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Museums in India

Poverty of Museums in India

THE recent publication of a book, *The Museums of India*,* by the Museums Association, London, should come as an eye-opener to our Government as well as to the Indian public, as it exposes in plain and straightforward language and with ample facts and figures a very serious, weak spot in the cultural life of the Indian nation. The book is a report of the tour in India conducted on behalf of the Museums Association by Mr S. F. Markham, Empire Secretary of the Museums Association and Mr H. Hargreaves, former Director General of the Archaeological Survey of India. The Survey and the report were made possible by the financial assistance provided by the Carnegie Corporation of New York.

The first thing that strikes one on reading the Report is the extremely small number of museums that serve the educational needs of the vast population dwelling in a country with the most ancient, varied, and rich cultural traditions in the world. If the proportion of museums to the population of a country be taken as an index to its cultural level, then India would well occupy the bottom of the scale along with the most backward countries in the world. Let us dwell a bit on this point. In Sweden, which is one of the most advanced countries from all points of view, there are 160 museums for a population of 6,150,000, *i.e.*, one museum for every 38,400 persons. In Germany (which possesses the largest number of museums in the world, *viz.*, 1700), one museum serves about 39,000 people. But let us take a backward region in Europe, say the Balkans; here there is one museum for every 262,000 persons. Even the most advanced Asiatic country, *viz.* Japan, has one museum for 120,000. The figures for comparatively backward countries like South America and Egypt are 790,000 and 875,000 respectively. But no country excepting probably the most backward ones can beat India, where the figure is one per 3,420,000, there being only 105 museums for a population of 359,000,000. Moreover, as the authors point out, most of these are ill-kept and the service is so bad that these hardly deserve to be called museums at all in the modern sense of the word. A large number of the big cities do not possess any museum at all. Some of the most conspicuous ones in this respect are Rangoon, (400,415), Ahmedabad (314,000), Amritsar (265,000), Cawnpore (244,000), Madura (182,000), Srinagar (174,000), Sholapur (145,000), Bareilly (144,000), and Meerut (137,000).

Besides being absolutely inadequate in number, Indian museums are very poorly financed and most of them offer very poor service to the public. The

The Museums of India by S. F. Markham, M. A., B Litt, M.P., Empire Secretary of the Museums Association, and H. Hargreaves, former Director General of the Archaeological Survey of India. Published by Museums Association, Chaucer House, London, W. C. I.

total amount from all sources spent annually on museums in India (including Burma) is about Rs 720,000/- which is less than what is spent on a single important museum in the more advanced countries of the West, the expenditure per head of the population on museums in India being about 200 times smaller than that in the United States or in Great Britain. Even making allowance for the fact that India is the poorest country in the world and the population is pre-dominantly rural, the above figures clearly prove that the museum service in India is hopelessly starved. Out of 105, about 46 have incomes of less than Rs 1000/- per year, on which it is impossible to maintain any sort of museum service, since it does not permit even the appointment of a paid curator. About 17 museums get Rs 10,000/- or more, and the authors of the Report find that some of these are surprisingly efficient for their income. But even in the best museums, the available money is hardly adequate, most of it being spent to carry out the usual routine work, and hardly anything is left for development or progress. For example, in the Geological Section of the Indian Museum, Calcutta, which is the foremost geological museum in the country (see page 26 of the Report), only a few hundred rupees per year are left for the purchase of material and specimens and for cleaning. With this budget, it is not surpristo find that this section is far behind in efficiency to the modern geological museums in Europe and America. Needless to add that with such poor financial support, it is not possible to expect efficient service. In all the three branches of museum activity, *i.e.*, preservation, interpretation, and educational service, Indian museums are very backward. The usefulness and status of a museum largely depends on the organization and efficiency of its curatorial staff. In India, only 20 museums have a whole-time, paid, competent curatorial staff, but in many of these the head curator has other duties besides the curatorship and naturally cannot give sufficient time or energy to educational and organization work, which, in consequence, is sadly neglected or left to ill-paid and ill-qualified assistants. The result of this state of affairs is that manuscripts, textiles, pictures, and woodwork, which require close observation and careful preservation are, as the authors have found, being gradually destroyed by beetles, moths, "silver fish", cockroaches and mites. The work of destruction by the insects is often helped by the rough methods of handling and exhibition employed by some curators, which are due to the present low standard of curatorship. This means that the future generations are being deprived of important documentary evidence of India's past greatness before our very eyes.

Labels are essential for interpreting the exhibits to the public and the ability to label an exhibit properly is regarded as one of the primary requisites of curatorship. In several museums in India, many exhibits are not only left unlabelled, but sometimes the business is left to illiterate *chaprashis*, with the result that some labels are turned upside down and sometimes interchanged with others and lost.

Modern Ideal of a Museum

The public in this country may put the question: what is the use of making such a fuss over the *ajaib-ghars* (wonderhouses)? This vernacular name for museums clearly indicates that the public, not even excluding those who have received modern education, have not much idea that a museum is not merely an *ajaib-ghar*, but a storehouse for knowledge which forms an important link in the chain of educational institutions, and with proper organization may be made to render immense service towards the cultural building up of the growing generations.

The original meaning of the word "museum" (The Alexandrian Museum, for example) was a temple dedicated to the Muses, the Goddesses of learning. They contained important collections of manuscripts, products of arts and crafts, and were placed under the charge of distinguished scholars. Students from far and near used to gather there to learn at the feet of these famous masters whose names have not yet been forgotten (Euclid, Ptolemy, Hero, and others).

Unfortunately, this original concept of museums was however long forgotten and until very recently, even in Europe, museums were regarded as mere

storehouses of curiosities, objects of historical importance and of products of arts and crafts. Most of the older museums in Europe started in this manner. In recent years, however, the museum ideals have undergone fundamental changes and and have shown a tendency to revert back to the ideal of the original Alexandrian Museum. The United States of America, being one of the 'younger' nations of the World, could secure only a small share of the European and the Near East antiquities but became the pioneer in the modern museum movement.

It is now generally accepted that the functions of a museum are chiefly educational and cultural, and they are not meant merely to house collections of weird and curious objects. Educational activities are nowadays so much emphasized that those of collecting and storing a large number of objects of interest are now considered almost of secondary importance. Thus the importance of a museum is now twofold: as a place of work for the scholar and as a place of instruction for the general public.

About the fifties of the last century, the publication of Darwin's *Origin of Species* evoked widespread interest in the fossil remains of plants and animals, and for properly housing such collections natural history museums were started in all countries of the world. Similarly, excavations in the Near East by Layard and Botta, and by Schliemann in Troy and Mycenae evoked great interest in ancient history, and to store these remains of monuments of ancient and vanished civilizations, archaeological museums were started. These collections naturally began to attract scholars on these subjects. It thus became usual for all important museums to provide special facilities for research workers.

The conception of museum as an educational institution is of more recent growth and is intended to serve the needs of the public in general and the growing generation in particular. A museum should be so organized that it may simultaneously serve as a place for recreation, combined with intellectual and aesthetic enjoyment, it should administer to the sense of beauty by exhibiting to the public famous objects of art, and above all it should be able to rouse the curiosity which leads to acquisition of knowledge. In the words of Sir F. G. Kenyon, Director of the British Museum,

> "It makes a man more aware of the world he lives in, of its extension in time and space, of the materials of which it is composed, of the trees and plants with which it is covered, of the animals that have inhabited it from the earliest times, of the activities of man, of his achievements in craftmanship and art. It illustrates written history and enlarges a man's conception of the possibilities of his race: so it plays its part in enlarging his mind, in multiplying his interest and in making him a better citizen."

With the change in the museum ideal from curio-collecting to helping in education of the public, there has been corresponding changes in the methods of exhibiting. Crowded rows of early museums are now replaced by carefully selected series of specimens illustrating the essential facts and so arranged as to be capable of instructing the museum visitors on sound cultural and practical lines. Modern museum service has to be active. It is no longer considered enough to stock a museum and leave the public to find out its value for themselves. Efforts are continually made to attract and interest the public by means of articles in the press, special exhibitions, gallery lectures, guide books, photographs (including picture postcards), etc. Regular lectures by educated guides are now usual in all the important museums in the West. Use of museum as a regular part of the education of children has recently been developed in the U. S. A. with great success.

Deutsche Museum of Munich

We can take the Deutsche Museum of Munich as a magnificent example of a modern museum. It is a monument of the inspired vision and foresight of its founder, Oskar von Miller. The Museum is housed in a specially designed set of buildings in a small island on the River Iser flowing through Munich. The total length of corridors housing the exhibit exceed 16 Km. in length and the number of visitors per year amounts to several millions. The total expenditure per year is about a million marks, but the museum has grown so popular that it is hoped that within a few years it will support itself from the visitors' fees.

In this museum, which is devoted only to science, exhibits are so arranged that the development of knowledge in any subject can be clearly followed. For example, in the series illustrating the development of X-rays, the old tubes of Hittorf and Plücker are shown, then comes Röntgen's original tube, and finally through all stages of development we come to the modern Coolidge tube and the metallic tubes. Things are so arranged that the visitors can themselves perform all experiments with these tubes by simply pressing plugs. Representative experiments on all scientific topics are similarly arranged, most of which the visitors can perform for themselves by following the accompanying instructions which are clear and concise. It is a common sight to find groups of school children performing representative experiments in physics and chemistry, whenever such experiments are possible. In subjects like mining and metallurgy, the exhibits are so arranged that on passing through them in the right order, a visitor can acquire a thorough knowledge of the subject. Competent guides are provided to deliver lectures and take the visitors through the exhibits. Mining is illustrated by actual models of mines of different kinds, *i. e.*, coal, iron, etc. In astronomy, lectures are provided in the famous Planetarium where the motion of the sun and the moon, of planets round the sun, knowledge of stars, their physical constitution are explained with the aid of stereoscopic projections on the revolving dome of the Planetarium. In the industrial section, the rise of an industry is illustrated with the aid of models which are operated by experienced guides. For example, in the steam-engine section, one can see experiments with Hero's toys, Savini's steam-plant for raising water from the wells, Newcomen's engine, the repair of which led James Watt to the epoch-making invention of the modern steam-engine, the various developments of steam-engine leading to modern internal combustion engines of Otto and Diesel and the steam turbine of Parsons. Periodically lectures are delivered by experts on the subjects, and anybody on payment of a small fee is allowed to attend these lectures. Recently the Prince of Wales Museum in South Kensington has also been reorganizing itself on this basis.

Lecture on Refrigeration

To illustrate the scope and usefulness of these lectures, we may take the lectures on refrigeration which were arranged in May 1936, at the Science Museum, South Kensington. The lectures were delivered by competent authorities like Travers and Simon who have taken the most prominent part in the development of low temperature technique. It is well known that England produces very little of her foodstuffs; she has to import meat from New Zealand and Australia, eggs and butter from Denmark, fruits from West Indies and Madeira. One to four weeks are taken in these voyages, and unless steps are taken to prevent meat and other foodstuffs from rotting, they will be useless. Hence almost all ships are provided with low temperature holds, where foodstuffs are properly stored. In England itself, the development of refrigerated gas storage of fruits has given rise to a great industry. All this requires that the general public should have a knowledge of the principles of refrigeration.

Lectures were delivered in the Museum by Travers illustrating the early methods of refrigeration. These were illustrated by the actual performance of experiments with apparatus permanently stored in the Museum. Simon completed the programme by his lectures on modern developments, *viz*., liquefaction of helium, production of absolute zero by the method of adiabatic demagnetization, and by demonstrating the remarkable changes produced in the property of bodies near absolute zero, *e.g.*, vanishing of electrical resistance. These lectures were very largely attended, and the audience evinced remarkable interest in the demonstrations. If we believe in the dictum that expenditure on education of the growing generation is the best investment for the Nation's wealth, such activity on the part of museums cannot but result in the production of a better educated generation for the future.

The Question of Power Alcohol in India

N. G. Chatterji
Harcourt Butler Technological Institute, Cawnpore.

THE recent press message about the unanimous recommendation of the Sugar Committee of the Imperial Council of Agricultural Research that the manufacture and use of power alcohol in India should be freely encouraged, provided it pays the same amount of excise duty as petrol, is of extreme interest, and should give satisfaction to the advocates of manufacture and utilization of power alcohol as an important step in advance. It is hardly four years now that from the figures arranged and made available to them at that time the I.C.A.R, Sugar Committee in their meeting of November 1933, came to the conclusion that the minimum cost of production of power alcohol would be annas ten per gallon, at which figure any extended use of the product becomes almost out of the question. This was the position when the writer returned to India in April 1934, after studying the power alcohol industry in most of the countries of Europe. It was with the greatest difficulty that he was able to convince people that power alcohol can easily be made at anything between four to six annas per gallon, and that at least in those parts of the country distant from port towns, it can be sold in fair competition against petrol. It must also be acknowledged that he would perhaps have never succeeded in gaining his point if in the meantime Mons Caupin of Messrs Pingris and Mollet-Fontaine, Lille (France), had not given him full support with his calculations obtained from the actual running of the Mysore Distillery at Mandya.

It may, at first sight, seem strange that once the above fact has been indisputably established, the manufacture and use of power alcohol should still not make any progress at all in the country. Indeed the majority of the people are under the impression that there are still intrinsic technical difficulties, and that further research work is necessary to overcome them. But the fact is that the real difficulties standing in the way are of an entirely different and extremely complicated nature. In this article, an attempt has been made to get a true perspective of the whole question in which are involved matters of high politics and political economy. The writer being primarily a student of science has no other apology to make for treading into the realm of political economy beyond the fact that the success in the working of an industrial scheme always requires an intensive study of its economic and political aspects after the technical difficulties have been overcome.

The technical aspects of power alcohol have already been discussed elsewhere[1] while a paper dealing with a scheme for the development of the power alcohol industry in U. P. was read before the Indian Sugar Technologists' Association in October 1935. A study of the history and growth of this industry in the more important countries of Europe reveals the following reasons common to all of them[2] :—

"(i) To minimize the heavy drainage of national wealth out of the country on account of imported petrol.

(ii) The advisability of having a national product as a substitute for petrol in view of the sad experience due to shortage of petrol in the country during the war.

(iii) To obtain freedom from the indirect tyranny of the powerful petrol groups which have often influenced the politics of the country.

(iv) The necessity of having a large supply of alcohol which is now regarded as an important munition – in other words, to be ready for war.

(v) To have a potential motor fuel available within the country—an important consideration due to the rapid mechanization of the army.

1. Chatterji, *Current Science*, March 1936.

2. Chatterji, *Chemical Age*, Oct. 1935.

THE QUESTION OF POWER ALCOHOL IN INDIA

(*vi*) The alcohol industry can be made to play a very important part in the prosperity of an agricultural country.

(*vii*) The heavy drop in the consumption of alcohol for drinking purposes."

The above reasons fall under three categories, namely, national economy, military offensive and defensive preparations, and agricultural prosperity.

Let us now analyse the conditions existing in India and try to classify under the above heads the various reasons that have been put forward by the advocates of power alcohol. Of these the most important are those falling under the last head, namely, agricultural prosperity. It is interesting to find that the present agricultural conditions in India are similar to those that prevailed in France just before the introduction of power alcohol in that country.

"The wine producers of the South had always kept on a fight in order to preserve the realm of potable spirit from being encroached upon by the distillers of the North. The trouble however became still more acute when after the War active help was given by the State to re-establish and expand beet cultivation in the devastated areas of the North. This was soon followed by an overproduction of beet and the world crisis in the sugar market. The only alternative to save the beet agriculturist was to direct his produce to distilleries and to find an increased outlet for alcohol in industries. Thus it is that the famous Congress of 'Carburant National' of Beziers was organized in April 1922 by the Agricultural Society of Beziers. This Congress had for its object the finding of a better formula for the utilization of alcohol as carburant and assuring in this way in the country an arm for national defence, a better balance of account, and a stable base for the development of agricultural prosperity."

In India also, active encouragement by way of tariff protection has led to overproduction of sugar and an accumulation of molasses for which there is at present little outlet in distilleries due to the teetotaler habits of the people.

What then is to be done? History teaches us that in similar circumstances there has been but one way out. It has been rightly said that if alcoholism is a national peril, alcohol is a national wealth. Distillation is the patrimony of agriculture. It is the manufacture of alcohol which permits often the worker of the soil to get a proper remuneration for his labour, and almost every government has therefore been striving to enable the agriculturist to earn a living from the land by utilizing surplus agricultural products in the distillery and finding a market for alcohol for industrial purposes.

Things have now come to such a stage in India that the only way to save the sugar industry from partial collapse and the sugarcane cultivator from ruin is to find a profitable outlet for molasses. Every effort has been made to discover such an outlet, even the strongly advocated but never successful attempt at exporting molasses has been for all practical purposes again a complete failure. It is therefore only after mature consideration and careful observation that the Sugar Committee of the I.C.A.R. has recently come to the conclusion that the manufacture and use of power alcohol is the only remedy.

Power Alcohol and National Economy

The part the power alcohol would play in the national economy of India would be of the same high order as it has been in other countries. At the present time, India consumes annually some 90 million gallons of petrol, the average c. i. f. price of which is -/5/- annas per gallon. Thus her petrol bill comes to about Rs 28,000,000/- per annum. As the indigenous petrol supplies are very small India has to purchase the greater part of her requirement from outside. The only way to reduce this drainage of wealth is to find indigenous sources of supply of a substitute, which *par excellence* is power alcohol. It is fortunate therefore that in molasses we have an abundance of very cheap and excellent raw material for making this liquid fuel—an advantage which none of the more important countries, using power alcohol, possess. Thus it may be rightly argued that in molasses India has the same resources of power as some other countries have in crude oil.

There are several other minor considerations which do not seem to attract attention at first sight. Thus it is computed that if 10 million gallons of power alcohol are manufactured per year, the requirement of coal would be about 33,000 tons—which would considerably help the present slump

in the coal industry. At the same time, there would be increased goods traffic for the railways, and a better balanced load in the tank wagon traffic.

Power Alcohol and National Defence

It hardly needs mention that national defence has been probably the most important consideration in the rapid development of the power alcohol industry in most of the countries of Europe. The mechanization of the army and the growing importance of the air-force have compelled the military authorities of every country to see that they have a regular and abundant supply of liquid fuel in the country. The problem is still more acute in India where, on account of the vastness of the country and long distances to be covered in transport from the port towns, there is always a certain amount of danger of the supply failing to reach the distant parts of the country at a critical period. To this must also be added the comparative insecurity and vulnerability of the petrol storage depots in the port towns at times of war and the irregularity of supplies coming from across the sea. Power alcohol is an ideal 'carburant', for it has great flexibility, in that mixtures containing, if need be, very high proportions of alcohol can be readily used in heavy types of vehicles and in aero-engines. For this reason even serious shortage of petrol in the country is not likely to impair in any way the mobility of the army if there becomes available an abundant supply of power alcohol in different parts of the country.

From what has been written above, one may wonder why, in spite of this, power alcohol is not making any headway at all in this country. The unanimous verdict is that the manufacture of power alcohol in India is a sound commercial proposition, for economic requirements, such as the fixation of price, organization for its distribution and retail sale of the petrol-alcohol mixed fuel, excise control, and such like matters, may be easily arranged. The fact is that in addition to the possible opposition from the powerful and organized petrol industry there are some other obstacles which are probably of a far more serious nature, and have had no counterpart in any other country. At present revenue accruing to the Government of India from the petrol duty consists of that realized from the total quantity coming into India, including the Indian States. With the introduction of power alcohol there is likely to be a substantial reduction in this revenue, for even if power alcohol were to pay the same duty as petrol, the States would appropriate the whole of the excise duty on the quantity of power alcohol produced within their territory. On the most conservative basis the loss in revenue on this account would be Rs 10 lakhs. However it need hardly be mentioned that, power alcohol being a federal subject, this aspect of the question need not present any serious difficulty towards an amicable settlement, especially in view of the fact that alcohol may be regarded as essentially an agricultural product of common interest to the whole of India.

Another important point for consideration is that power alcohol may now be regarded just as important a munition of modern war as explosives, so that it is a debatable point how far it is advisable in India to have private factories engaged in its manufacture. At the same time it is also recognized that the country should be fully prepared for any contingency in the shortage of the supply of petrol. Indeed, some authorities go even to the length of saying that the organization within the country should be such that the civil population may be in a position at any time to give up their requirements of petrol for military purposes even outside the country, without any serious dislocation of civil life. Looking from all points of view, this aspect of the question appears to be merely of an alarmist nature, and with power alcohol factories spread out over the country and working under Government supervision their potentialities as faithful allies are really very great.

Thus the introduction of power alcohol in India involves a number of questions of policy, and every step forward has to be taken cautiously. The matter is so important that a start by way of experiment should at once be made in one area, and the results carefully observed. In this respect U. P. is the ideal area where the first efforts should be made for the manufacture and use of power alcohol.

Fruit Research in England

P. K. Sen

Imperial Council of Agricultural Research, India.

Early Days

FRUIT growing is not a new craft in England. In the earliest accounts of the country that have been preserved, incidental mention is made of a "pomarium" or "apple garden" attached to the old monastic houses. Presumably the traditional crafts that had survived from the old Roman civilization found their way to England from the Continent by way of these religious foundations.

Even in those early days the apple was grown both for eating and cider making. To quote instances:[1] 'in 1205 the manor of Runham in the county of Norfolk was held, by petty sergentry, by the payment into the exchequer each year on the feast of St. Michael of two hundred pearmains (a variety of apple) and four hogsheads of wine made from pearmains. The garden of the Norwich Monastery in 1340 sold apples and pears which brought in 13s. 4½d. The accounts of a garden in Holborn belonging to Henry de Lacy, Earl of Lincoln, show that in 1291-96 apples, pears and great nuts sold for £9, after the tithe had been deducted.'

During the 16th century England was brought into close touch with France and the Low Countries and this resulted in the introduction of new ideas on the subject of fruit growing, especially into Kent which lay nearest to these countries and was therefore the first to receive the impact of these new horticultural practices. Thus one reads in *The Husbandmans Fruitful Orchard* of 1609 that one Richard Harris the Fruiterer of King Henry the Eighth brought grafts of apples, pears, and cherries, and planted them in a big orchard in Kent which eventually became the mother of most similar fruits in England.

Orchard fruit growing, however, was not introduced in England before the middle of the 16th century and Fuller in his *Worthies of Kent* gives the credit for this to refugee Flemings. About this time fruit growing attracted popular interest, and books on gardening began to appear.

Beginning of Fruit Research

In this country the application of science to the art of growing fruits may be said to have begun with Thomas Andrew Knight, President of the Royal Society of Horticulture (1811-1838), who was one of the first to apply the discovery of sex in plants to fruit breeding.

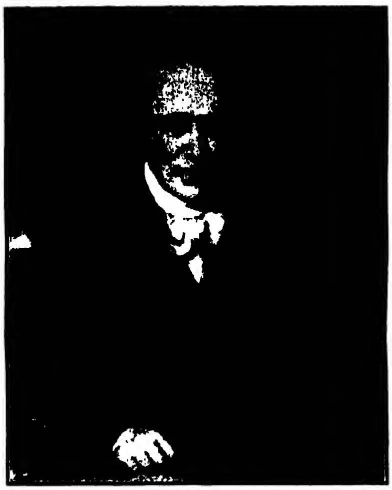
The Royal Society of Horticulture

It was to the initiative of John Wedgewood that a small group of garden lovers met at a bookshop in London on March 7, 1804, with the object of founding a society 'to collect every information res-

JOHN WEDGEWOOD, the Founder of the Royal Horticultural Society in 1804

1. *The Apple* (1933)—by Sir Daniel Hall and M. B. Crane, Martin Hopkinson, Ltd., London.

pecting the culture and treatment of all plants and trees—as well culinary as ornamental—to foster every branch of horticulture and all the arts connected with it.' The Horticultural Society thus



THOMAS ANDREW KNIGHT, the Second President of the Society, elected in 1811

founded later became 'Royal' and today it is the largest and most influential of all horticultural societies.

Only a few of the present-day activities of the Society can be mentioned here. Its fortnightly exhibitions of fruits, flowers, and vegetables are very instructive and generally popular to all interested in gardening. The publications of the Society are one of its major functions. The publication of monographs and pamphlets on various cultural subjects have also been of great value to horticulture the world over. The advisory work of the Society and the institution of examinations for a National Diploma of Horticulture also form an important part of its work.

On the experimental side the trials of fruits, flowers, and vegetables represent an important part of the Society's work carried out in its gardens at Wisley in Surrey. Some forty acres of land are there devoted to fruit tree trials for the purpose of testing new varieties which may have qualifications for market use, and to maintain a standard collection of fruits with which the performance and behaviour of new varieties can be compared and their qualification accurately judged.

Woburn Experimental Fruit Farm

No doubt the new fruits first introduced from abroad and later raised by Thomas Andrew Knight brought great enthusiasm in the fruit gardening of England early in the 19th century, but it was not until 1894 that fruit research, as we know it, was started at the Woburn Experimental Fruit Farm by Spenser Pickering, in association with the Duke of Bedford.

Woburn under Pickering's inspiration opened up lines of systematic investigations into all the most important problems of the fruit plant, such as planting, manuring, pruning, response to climate, flowering, fruiting, diseases and their cure, etc. It may be said that the highly technical horticultural experiments that are being carried on all over the country today are but the logical sequence to the work started by Spenser Pickering in 1894.

SPENSER PICKERING, M.A., F.R.S. (1858-1920)

FRUIT RESEARCH IN ENGLAND

Long Ashton Agricultural and Horticultural Research Station

About a year before Pickering started investigations into the cultural problems of fruits at Woburn, the Squire of Butleigh initiated research into matters relating to the manufacture of cider. The work at Butleigh (West of England) was started in 1893 under the direction of F.J. Lloyd with the object of reducing the manufacture of cider to a definite method and system. From the commencement the work was financially supported by the Bath and West Agricultural Society and by the Board of Agriculture. The value of the work soon became apparent, and the desirability of its extension was felt by everybody concerned. Thus in 1903, the National Fruit and Cider Institute was established at Long Ashton near Bristol through the joint efforts of the above mentioned societies and the Board of Agriculture.

Season after season the importance of the Institution became increasingly apparent and later in 1910, as a result of the country-wide extension of the activities of the Board of Agriculture it was reorganized under the able directorship of Professor B. T. P. Barker as a department of the Bristol University under its present name. It is engaged with its full complement of scientific departments on all relevant matters concerning fruit production and fruit utilization including cider manufacture, canning, bottling, preparation of syrups and juices. Space will not allow a detailed description of all the many achievements of this Institution. Its investigations into the nutrition of apples, the consequent solution of the 'Leaf Scorch' problem caused by potash deficiency, led to the enormous improvement of the quality of the fruit and the profitable extension of fruit culture in large tracts hitherto reckoned as unsuitable for fruits.

John Innes Horticultural Institution

The John Innes Horticultural Institution, Merton, London, was founded under the will of the late John Innes, a merchant of London and a general benefactor of the public, who died in 1904. It began its work in 1910 under the directorship of the late William Bateson, the pioneer geneticist of England. Bateson was director till his death in 1926. His researches brought the Institution international reputation which has since been enhanced by the ability of its present director, Sir Daniel Hall, F.R.S., and by its association with Professor J. B. S. Haldane, F.R.S., who is now in charge of its genetical work. The cytological contributions of this Institution have also been great.

To cite one or two of its researches on fruits, the investigations of Mr M. B. Crane into cross- and self-fertilization among the varieties of apples, pears, plums, and cherries, elucidating some of the "incompatibility" problems in fruit growing, have afforded a sure basis of selection of fruits.

Furthermore, its investigations into the inheritance of characters in apples opens up a new field for research workers in all parts of the world and with all kinds of fruits.

East Malling Research Station

In the east of England fruit research was not started until 1912 when an influential body of fruit growers from Kent supported by the authorities of the South Eastern Agricultural College, Wye, Kent, approached the Government with a request for the establishment of a centre for scientific investigation of their problems. As a result of this the Wye College Fruit Experimental Station was established at East Malling in 1913. Since then, the fruit growers of Kent have always played the leading part in the history of East Malling Research Station now so well known for its research on Root Stock Effect.

Soon after the Research Station started work, the Great War began and there followed a critical time for the infant institution. Its first director, Mr R. Wellington, was called away to military duties and his second in command, the present director, Dr. R. G. Hatton, came forward and took charge of the experiments.

After the War the Station was reorganized into an independent institution with an extensive research programme. At present, the institution which was

started on only 23 acres of land with 3 workers has over 150 acres of experimental plantations and a whole team of experts in all branches of horticultural science investigating every aspect of hardy fruit culture.

Although primarily concerned with its own problems East Malling, like every other similar institution in England and elsewhere, plays its full part in the pomological research of the whole world. Its discoveries of the influence of 'root stock' on the behaviour of the scion in a budded or grafted tree has opened up a new era in horticulture.

The Low Temperature Research Station, Cambridge and the Ditton Laboratory, East Malling

Whilst the research institutions described above are primarily engaged on studies in fruit production, these two are investigating the best methods of fruit storage.

The needs of the War days stimulated intensive investigations into food problems. The Public Health Department, the Development Commission, and the Medical Research Committee started the work, and in 1918 the Food Investigation Board was formed, under the directorship of the late Sir William Hardy, to organize and control research into the preparation and preservation of food. Research in the storage of fruits received its incentive under the auspices of this Board. Preliminary work was taken up by the Cambridge University, the Imperial College of Science and Technology, London, and the Long Ashton Research Station. With the progress of the work it was felt that a thoroughly equipped laboratory should be found for storage research. Thus the Low Temperature Research Station at Cambridge came into existence in 1922 out of the contributions of the Food Investigation Board and the Empire Marketing Board on a site given by the Cambridge University.

To begin with, fruits were stored at a low temperature and a search for the most suitable temperature conditions formed the major problem of the scientific workers. The fruit, however, is a living body, and the limitation of the methods of cold storage soon became apparent, since chilling was found to interfere with the living condition of the fruit, and in addition the influence of the fruit itself on its storage was shown to be important. Investigations based on the characteristic gaseous interchange in the respiration of the fruit led to a method of low temperature gas storage—providing the fruit during storage with an atmosphere of balanced oxygen and carbon-dioxide at which respiration is maintained at the minimum rate.

The effect of the investigations on the fruit industry was obviously very great. The possibility of lengthening the life of the fruit promised better marketing. The gas storage method actually indicated prospects of keeping apples in perfect condition as long as twelve months. This brought increased enthusiasm to the overseas growers, for the prospect of improvement in the shipping of fruits from countries like Australia, New Zealand, South Africa, to Europe became apparent. Largescale experiments on the storage and transport of fruits were planned jointly by the Food Investigation Board and the Empire Marketing Board. With this object the Ditton Laboratory was established at East Malling in 1927 and for it the Empire Marketing Board alone contributed £15,000.

The effect of soil, climate, and variety on the storage properties of fruit had already been studied to some extent. It was assigned to the Ditton Laboratory to study (*i*) the storage of fruits on a semi-commercial scale and (*ii*) the influence of humidity upon storage properties. Further, the Laboratory was situated bordering the East Malling Fruit Research Station in view of the possibilities of examining the influence of the root-stock upon storage properties in the fruit.

Storage of fruit has now become a common practice. True, fruit is grown only during the summer, but apples are available now every day of the year as fresh as just picked from the tree, and even softer fruits such as pears, plums, and berries can be kept for longer periods than before.

Fruit and Vegetable Preservation Research Station, Campden

Soon after the War began, experiments on the preservation of fruit and vegetable were stimulated by the Ministry of Agriculture and Fisheries and the Development Commissioners. The Agriculture and Horticulture Department of Bristol University started work at Studley College in co-operation with Dr L. Hamilton and at Dunnington Heath with Mr C. S. Martin on his farm there, on preservation by drying, canning, and other methods. Arising out of these experiments two experimental factories were started, but the course taken by the War made it imperative that attention must be diverted from the experimental to the purely productive aspect. With this object in view a large factory was planned and some premises were purchased by the Government at Campden in 1918. But when after the War the food emergency vanished the Ministry of Agriculture stimulated investigational work on the preservation of horticultural produce rather than immediate increase in production.

In 1921, the Ministry decided to offer the responsibility of the institution to the University of Bristol. It has since developed into an important research station playing a great part in the growth of the canning industry of England. It has determined by research the varieties of fruit and vegetables most suitable for canning and is studying every aspect of canning.

For some years now, short courses in canning have been given under the auspices of Campden Research Station and Long Ashton.

Other Centres of Fruit Research

Besides the above institutions, a certain amount of work on problems of fruit production is done in a number of teaching institutions under the various universities. Of these the South Eastern Agriculture College, Wye, Kent, and the Department of Horticulture, Reading University, have done important work.

Scotland is not an important fruit growing country owing to its extreme climate. Conditions do not favour the tree fruit such as apples, pears, plums, cherries, but small fruits, *e. g.*, raspberries and strawberries, are grown there to some extent, and the agricultural colleges of Edinburgh and Glasgow are investigating certain problems of a horticultural nature.

The Imperial Bureau of Fruit Production

In conclusion mention must be made of the vital part played by the Imperial Bureau of Fruit Production housed at East Malling Research Station, in the fruit research of England and of the Empire. Like all other Agricultural Bureaux in this country it owes its origin to the Imperial Agricultural Conference of 1927, and started work in April 1929, under the able directorship of Dr R. G. Hatton, who, as mentioned above, is also the director of the East Malling Research Station. It acts as a bureau of information respecting fruit research in general. Its technical communications and the quarterly publication of the *Horticultural Abstracts* must now be regarded as indispensable to scientific horticultural workers all over the world.

The author tenders his grateful thanks to the Bureau for its assistance in collecting information from various sources for the preparation of this article.

The Mystery of Cosmic Radiation—Part II*

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Wave or Corpuscle?

EVER since the publication of Hess's† work in 1912 which conclusively proved the existence of a highly penetrating radiation coming from above, a considerable amount of theoretical as well as experimental work has been done purporting to discover the nature of this ultra-penetrating radiation. There have been two schools of workers, one advocating the view that the cosmic rays consist of ether waves and the other maintaining that experimental evidence justifies the conclusion that the cosmic rays are electrically charged particles (electrons, protons) moving with velocities approaching that of light. Attempts have been made to devise experiments capable of giving a decisive verdict about the truth of the one or the other view. One of the most fundamental experiments of this type was that of Bothe and Kolhörster (1929) who employed the then recently invented tube-counters of Geiger and Müller for counting the so-called cosmic ray "coincidences." These counters are, as is well known, capable of detecting single rays. In this famous experiment, which gave a fresh impetus to the study of cosmic rays, Bothe and Kolhörster had two tube-counters arranged one above the other but in no way connected with each other. They found that an appreciable fraction of the total number of impulses of both the counters was *simultaneous* (two impulses were taken to be simultaneous if the time-difference between them was 1/100 second or less). These simultaneous impulses were called *coincidences*. When the counters were arranged side by side, that is, in a horizontal plane, the number of coincidences decreased. If the counters were mounted one above the other, that is in a vertical plane, and a block of gold 4.1 cm. thick was interposed between them, then also there was a decrease. In the first case the decrease was exactly what could have been expected from the geometrical conditions and the decrease in the second case agreed with the known absorption coefficient of gold for cosmic radiation. Thus the observed coincidences (*minus* the chance coincidences expected from the geometrical conditions and probability considerations) are a measure of the cosmic-ray impulses. Bothe and Kolhörster saw in this method a possibility of deciding whether the cosmic rays are corpuscular or are a kind of supergamma rays.* They tried the coincidence experiment with γ-rays from radium and found that coincidences could be obtained only when the electrons produced by the effect of the γ-rays on one of the counters could enter the second counter without being stopped by the walls of the counters or by any interposed absorbing material. They concluded therefore that cosmic rays were corpuscular, for secondary electrons produced by γ-rays from radium could not presumably pass through a 4.1 cm. thick block of gold. It is worth noting, however, that their coincidence experiments do not make the conclusion drawn by Bothe and Kolhörster inevitable, as it is obviously based on the assumption that secondary electrons produced by γ-rays of the penetrating power of the cosmic rays must also have a penetrating power of the same order as those produced by known γ-rays. But the

* Part I was published in Vol. II No. 3. P. 121

†The importance of Hess's work has been recognized by the award of a Nobel Prize in 1936 (See SCIENCE AND CULTURE Vol. II. p. 3057

*γ rays are e.m. waves whose wavelength is about 1000 times less than those of X-rays. They have therefore, according to Quantum Theory, thousand times more energy than X-rays.

Millikan Theory of Origin of Cosmic Rays

argument fails if the cosmic γ-rays were much more, say a thousand times more, penetrating.

As a matter of fact Millikan and Cameron (1931) brought forward experimental evidence, which, according to them, supported the view that cosmic rays were like γ-radiation and were produced in accordance with the hypothesis put forward by Eddington (1926) that cosmic rays have their origin in the building up of heavy elements in distant regions of space occupied by diffuse matter out of the elementary particles, the proton and the electron —a processs in which the loss of mass due to the "packing effect" can be converted into radiation. Millikan described the process in his own picturesque language, "God Almighty is still at his job in his workshop." The attractive idea of Jeans, which has been recognized as indicating the most probable source of stellar energy, namely, that matter is annihilated due to the falling together of electrons and protons and is converted into radiation, found favour with some workers. Now, Regener (1928, 1930) shewed from his absorption experiments in Lake Constance with the help of high-pressure ionization chambers as well as Geiger counters that the spectrum of cosmic rays consists of four components of different penetrating powers; the absorption coefficients of the three hardest components were found to be 0.20, 0.073 and 0.21 respectively per metre of water, but the absorption coefficient of the longest component could not be determined with sufficient accuracy. Even if we assume that these are the only lines or bands of the cosmic-ray spectrum (although the works of Kolhörster and Corlin indicate the presence of still harder components as well), it is not possible to find a satisfactory explanation of the origin of all the four components on the hypothesis of annihilation of matter. The hardest components may, however, be explained, as Jeans has urged, by the annihilation of one α-particle and its two neutralizing electrons, and the next softer component by the annihilation of one proton and its neutralizing electron. To make a long story short, neither Millikan's nor Jeans' theories, attractive as they were, stood the test of experiments.

Deflection of Cosmic Rays

If the cosmic rays be really corpuscular in nature then the constituent corpuscles are most likely to be electrically charged elementary particles, namely, the electrons and protons. This opens up a new possibility of making a crucial experiment to settle the controversy regarding the nature of the cosmic rays. Accordingly B. Rossi (1931) tried to find out whether the cosmic rays could be deflected by a strong magnetic field. By using a field of the order of 16000 gauss he could not obtain an unmistakable deflection so that the conclusion that could be drawn from his experiments was either that the cosmic rays do not consist of electrons or protons or that the constituents are electrons or protons of energies greater than 10 or 20 milliard electron-volts.* Although Rossi's magnetic experiments did not lead to any definite identification of the corpuscular nature of the cosmic rays *other experiments have yielded very trustworthy evidence in favour of the view that cosmic rays consist of electrically charged particles of very high energy rather than photons.*

Discovery of Positron

The new technique which led to these discoveries was first invented by the Russian worker, Skobelzyn, in 1929. It is well known that it is possible, with the aid of the Wilson cloud chamber, to take photographs of charged particles. Witness, for example, the tracks of α-rays which are found in every advanced textbook on physics. These tracks are generally straight and thick. But the tracks of electrons (β-rays) consist of zigzags, and are *usually thin*; when the velocity of electrons is nearly that of light, the path becomes straight, but continues to be thin. The γ-rays have no path of their own but are indicated by the path of electrons which they release by Compton collisions or otherwise. An experienced worker can, by looking at the picture,

*It is usual to measure energy of particles in millions of electron-volts. According to Einstein, mass and energy are equal, the mass of an electron is equal to half a million electron-volts. In cosmic-ray analysis, electrons and positrons possessing energies of billion (10^9) electron-volts and higher have been found.

say whether the track is that of an electron, an α-particle, or a proton.

Skobelzyn put the Wilson chamber in a magnetic field, the direction of motion of the particle being at right angles to the field. This converts the straight paths of charged particle into a curve, and from the direction and amount of curvature it is possible to tell not only about the mass and charge of the particles but also of their energy. He got many unexpected results, *e.g.*, he found from cosmic rays electrons of extremely high energy, but also particles which were curved in the opposite direction. Skobelzyn's experimental arrangement was further improved by C. Anderson in the California Institute of Technology, and by P. J. M. Blackett in the Cavendish Laboratory, Cambridge. They used much higher magnetic fields and a series of Geiger counters to act as collimators for cosmic rays, and also as firing device. Two or more Geiger counters were arranged vertically above each other and about the Wilson chamber, and by a clever etectrical device, the Wilson chamber was fired (*i. e.*, was allowed to expand) only when the cosmic ray had passed through the Geiger counters above. This enabled them to find out the direction of the cosmic ray entering the Wilson chamber, and finding out its path under the magnetic field simultaneously.

Both Anderson and Blackett were puzzled to find that in addition to electrons, particles having apparently the same charge and mass but with opposite curvature were found. These tracks could not be due to α-particles or protons, as they were very thin. They could only be due to the 'positive electron.'

The announcement of the discovery of the positron was boldly made by C. Anderson in 1933. As is clear from the above account, this discovery is a byeproduct of the work on cosmic rays. Anderson, who, at Millikan's instigation, started to disprove the corpuscular theory, was rewarded with one of the most fundamental discoveries in physics. Like Saul, he set out to seek for his father's asses, but was rewarded with a kingdom.

It is not quite right to say that the "positron" had not been predicted. In fact the existence of elementary particles of electronic mass but with positive electrical charge had previously been made probable by the relativistic wave-mechanics of Dirac, though in a way which did not much appeal to experimentalists. They were regarded as holes in a medium filled with negative electrons. Almost simultaneously with Anderson, Blackett and Occhialini obtained the same results with the help of a more convenient automatic device for photographing the tracks of cosmic-ray particles in a Wilson expansion chamber simultaneously recording the coincidence with Geiger-Müller tube-counters.

Discovery of Showers

They also found that many of the particles diverge from a single point inside or outside the chamber (*showers*), ten or more such radiant points being detected in some cases.

The improved recent experiments of Anderson and Neddermeyer (1936) as also of Blackett (1936) on the same lines show that a "shower" may consist of more than 100 and sometimes even 1,000 tracks. It is to be noted that some years ago Hoffmann had observed in his ionization chamber experiments sudden increases of ionization (Hoffmannsche Stösse), the cause of which was not then clearly understood. Now it is clear that these Hoffmann Stösse are due to shower production. The study of the shower phenomenon is of the utmost importance for deducing the nature of the primary cosmic rays and their method of absorption, for what are actually observed are not the primary rays, but only secondary shower particles. Recently E. Lenz (1931) has succeeded in deflecting cosmic rays also by strong electric fields. With a field of 700 volts per centimetre he finds more positive than negative particles, while with a field of 70,000 volts per centimetre the number of negative particles is greater than that of positive particles. It would seem therefore that particles observed with the more intense field are chiefly primary corpuscles, whilst the deflected particles observed with the weaker field correspond to what are known as "shower" particles.

Cosmic Rays in Earth's Magnetic Field

The most conclusive evidence in favour of the corpuscular nature of the primary cosmic rays is provided by a type of magnetic experiment in which the magnetic field of the earth itself serves as the deflecting field. Just after Bothe and Kohlhörster's announcement in 1929 that cosmic rays were corpuscular, they pointed out that on account of the focussing action of the earth's field, their intensity would vary with the geomagnetic latitude. These experiments consist in measuring the intensity of cosmic radiation at different geomagnetic latitudes as has been done by J. Clay of Amsterdam and A. H. Compton (and his collaborators) of America. Although Millikan, Bothe, Kolhörster, Wölcken, and a few others failed to observe any remarkable difference in cosmic-ray intensity between high and low latitudes, Clay, who made a voyage from Java to Holland in 1932, found a consistently lower intensity near the equator than in Europe, while the geographical survey organized by A. H. Compton unmistakably demonstrated that at sea-level the change in intensity from the highest to the lowest latitude was 14 per cent and at 4400 metres it was 33 per cent. It was also found that the intensity-ionization curves in Compton's survey lay definitely higher for high latitudes than for equatorial regions. These results are in good agreement with the theory, first put forward by Störmer and Epstein and more completely worked out for cosmic rays by Lemaître and Vallarta, that the cosmic rays consist of electrified particles coming into the earth's atmosphere from remote space and are affected in their geographical distribution by the earth's magnetic field. According to this theory, particles of energy less than 10^9 electron-volts approaching the earth reach it only at latitudes north of about 60°, while the earth's magnetic field cannot affect the geographical distribution of particles approaching with energies greater than about 5×10^1 electron-volts. Fo intermediate energies, there will be a latitude effect according to the distribution of energy of the incoming particles. Neither the above theory nor the results of the earth-magnetic observations are capable of distinguishing between positively and negatively charged particles, but the observational results appear to contradict definitely the photon hypothesis regarding the nature of the cosmic rays. For, if the primary rays were photons, then the secondary charged particles produced by the collision of these photons with air particles would not be deflected, in the way cosmic rays are observed to be, by the weak magnetic field of the earth ; the magnetic field of the earth can deflect charged particles of high energy only if they travel great distances in the field. It may however be that the radiation observed by Millikan, Regener, and Kolhörster under great depths of water, in some cases reaching about 700 metres, may be really photons produced in the same way as photons are produced by cathode rays striking a target. Thus at low altitudes in the atmosphere a mixture of electrons and photons may be present, but the measurements at great altitudes do not favour the view that an appreciable portion of the primary cosmic rays can be photons. The possibility, however, is not completely excluded that a small portion of the primary cosmic rays may be neutrons as well. As far as can be judged from the earth-magnetic observations, one can at present say with certainty that cosmic rays consist principally of charged elementary particles entering the earth's atmosphere from outer space. The earth-magnetic observations cannot however decide whether the primary rays are electrons or protons, and there is no other direct evidence to decide whether the primaries have a protonic or electronic mass. But indirect evidence is available from the phenomenon of "showers" in cloud chamber experiments in a strong magnetic field combined with Geiger-Müller counters. The beautiful photographs of showers obtained by Blackett, Anderson, Kunze, Stevenson, and others show that the shower particles are mainly electrons and positrons in about equal numbers, while a very small portion of the particles, about one per cent, are either protons or α-particles. The mechanism of shower formation is not clearly understood, but it appears that the shower particles are not the result of disintegration of atomic nuclei which have been hit directly by the primary cosmic-ray particles, for the total energy of shower particles is much higher

than that of any nucleus, even the heaviest. The energy of the shower must therefore come from the primary cosmic ray. The latest photographs of showers show that the shower particles do not diverge from a single point but start from a number of points. Blackett advocates the view that the primary cosmic-ray particles, through some yet unknown process, produce a cluster of extremely hard photons which have practically no ionizing power and are therefore not photographed, but each such photon on encounter with matter gives rise to a pair of electrons, one positive and the other negative, so that a shower consists of a group of many such electron pairs. According to Heisenberg, the shower particles are due to the induction of pairs of positrons, electrons and neutrinos from the nucleus by a passing high-energy cosmic ray (see SCIENCE AND CULTURE, Vol. II, p. 133). Thus the formation of showers is closely related to the process of absorption of cosmic-ray particles, and we can expect that a better understanding of the one phenomenon would materially advance our knowledge of the other. But it is extremely difficult on the one hand to draw any unquestionable conclusion from the results of absorption experiments on cosmic rays, and on the other hand present theory is quite unable to deal with the process of absorption of such high energy particles as the cosmic rays. It is certain that the primary rays are mainly absorbed by shower formation. If the initial act of shower production be the emission of a cluster of photons, as suggested by Blackett, during a collision of a primary ray with matter, then according to quite general theoretical considerations, such radiation processes should be much more frequent for electrons than for protons. Thus the primary cosmic rays are probably electronic (both positive and negative).

Early Man in Asia

An important symposium on Early Man was held recently at the Academy of Natural Sciences of Philadelphia to mark the 125th Anniversary of the Academy. Among the British representatives attending were Miss Dorothy Garrod and Professor V. Gordon Childe. Considerable interest was aroused at the opening session by a group of papers of special significance in their bearing on the problem of the evolution of man, and the dating and distribution of early forms of his culture. They opened with a survey of man's geological record in Java by Dr G. H. R. Von Koenigswald, official palaeontologist, Java Service, followed by an account of the palaeolithic industries of China by Mr W. C. Pei, who discovered the first Peking man skull in 1929. This communication was notable as the first comprehensive survey of the material to be submitted to a western audience. Mr Pei classified the main palaeolithic industries into four groups; but he also referred to two earlier industries which had been recognized by the Abbé Breuil, the Nihowan, represented by one worked stone and some worked bones, dated as Upper Pliocene and equivalent to the Villefranchian of Europe; and Locality 13 industry, represented by a chert implement of undoubted human origin, belonging to an early phase of the Lower Pleistocene and corresponding to the Abbevillean of France. Of the four main industries, the Sinanthropus, which may safely be said to begin the true industry of China, belongs to the Lower Pleistocene and is attributed to the Abbevillean in the French palaeolithic sequence. It is followed by the newly discovered and little studied Locality 15 industry from Choukoutien, the cave which was the home of Peking man. This industry may belong to the early Middle Pleistocene, and corresponds to the Late Lower Palaeolithic of Europe. The Ordos industry...is contemporary with part of the Chinese loess and may be attributed to the Late Middle Pleistocene. —*Discovery*, June, 1937.

Vernalization—a new Russian Method of Crop Production

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THE most remarkable achievement in agriculture during recent years has been the Russian discovery that by suitable treatment of the seeds before sowing, crop production can be greatly hastened. Prof. T. D. Lysenko of the Odessa Institute of Plant Breeding discovered the process in about 1928 and called his method "Jarovizacii" in Russian though it is now more widely known by its latinized form "vernalization." By this process, many plants are made to mature very early making it possible for two crops to be raised in the same fields in the course of a year. It has also enabled the Russians to extend crop cultivation to places within the Arctic circles where this had hitherto been impossible.

Nature of the crop plants

Plants, it is well known, flower at a particular time of the year, but this was held to be due to a response to the temperature. Garner and Allard in 1918 showed that variations in the length of the day is also an important factor. Generally speaking, there are two kinds of plants: (*i*) Short-day plants which require only a short (less than 12 hours) daily exposure to light in order to produce flowers. Examples of short-day plants are :—millet, sorghum, maize, rice, soyabean, French bean, cotton, tobacco, subtropical cereals (autumn varieties), chrysanthemum, etc. These are generally sown in autumn when the temperature is high but grow in the short winter days. (*ii*) Long-day plants. These require a long (more than 12 hours) daily exposure to sunlight for flowering. Temperate cereals (spring varieties of wheat, barley, etc.), garden pea, potato, lettuce, opium poppy, red clover, runner bean, radish, etc., are generally sown in the colder spring days and grow during the long days of the summer. The temperature during germination and the length of the day in later stages are both important. If long-day plants are grown under short-day conditions or *vice versa*, flowering is inhibited or long delayed. *Sedum spectabile*, a long-day plant, was prevented from flowering for 9 years by growing under short-day conditions but flowered at once on exposure to full-day length. In England there is a saying among the farmers, "Plant potatoes when you will, they won't grow till April." This is because potatoes require the long days of April for their growth. The difference between long and short days is clearly marked in western countries.

Method of vernalization

Gassner in 1918 showed that if germinating seeds of winter cereals be kept at a temperature near freezing point for about a month and then sown, the plants mature very early. This method as such is obviously quite impracticable for cultivators' purposes as the seedlings become too large to be handled. Lysenko hit upon the idea of retarding their growth by limiting the supply of water. The seeds, then, remain fit to be sown in the usual way and can even be dried and stored for a time.

The precise method of vernalization varies with different plants and also with different varieties of the same plant. To obtain successful results it is therefore necessary to determine the exact conditions for each form. Winter wheats are first soaked in water and the weight of the absorbed water should not be more than 50% of the dry weight of the seed. The normal water content of winter

VERNALIZATION—A NEW RUSSIAN METHOD OF CROP PRODUCTION

wheats is 12-14% and so about 35% more water by weight is required. It is better to determine the original moisture content for each sample. The seeds are kept in this water for one or two days at room temperature when they get swollen and the embryos begin to emerge from the seed coat. They are then kept in darkness at a temperature of 35-36°F (near freezing point) for 40-50 days. After this period the process of vernalization is complete and the seeds are ready for sowing. Spring varieties of wheat generally contain more water and so less of extra water is necessary. They are vernalized at a slightly higher temperature and are required to be kept in darkness for a shorter period. The late spring varieties require 38-42°F for 10-15 days whereas the early forms need to be kept at 47-50°F for 5-6 days only for vernalization.

Field Operations

For field sowings the seeds are spread on cement floor and the requisite amount of water is supplied in three successive stages, after each of which they are mixed thoroughly with a shovel. The layer of the grains should be kept thin, otherwise the temperature will automatically rise due to accumulation of the heat of their respiration. This is also necessary for proper aeration of the seeds. In colder parts of Russia vernalization can be brought about by opening the windows at night but in other countries artificial refrigeration is necessary. Proper proportion of moisture must be maintained during the whole process, as failure is often due to the narrow range of moisture content permissible. If the grains become too dry, vernalization will cease and it is better to add about 5% more water. If too wet, the seeds will germinate too far. This can be avoided by adding some (up to 10%) dry grains of the same variety. Efforts have been successfully made to prevent undesirable growth by the use of harmless, 'balanced' salt solutions instead of pure water. Moisture during vernalization encourages the growth of moulds. This can best be prevented by keeping the vessels clean and by disinfecting the seeds by soaking them before the second application of water in either ·13% formalin for 3 minutes or in ·1% corrosive sublimate for 10-15 mins. Best results are obtained if the seeds are sown immediately after vernalization and therefore treatment should be started at such date that vernalization is finished on the day of sowing. If absolutely necessary vernalized seeds may be dried for storage by adding about 30% more dry seeds of the same variety, but in no case should they be kept more than 15 days before sowing.

Vernalization of other plants

Short-day plants generally require to be kept at a higher temperature but for a shorter period and in total darkness or exposed to short periods of light. The conditions for vernalization for a few typical crop plants are given below :—

Crop.	% of Water.	Temp.	No. of Days.	Light condition.
Short-day plants				
Millet	26%	70-80°F	5-7 days	darkness
Sorghum	26%	70-80°F	8-10 ,,	,,
Maize	30%	70-80°F	10-15 ,,	,,
Soyabean	75%	70-80°F	10-15 ,,	,,
Cotton	60%	68-77°F	15	,,
Lentils	60-70%	47-50°F	10-12 ,,	,,
Rice	——	38-41°F	14 ,,	,,
Long-day plants				
Wheat	50%	34-36°F	40-50 ,,	,,
Barley	40-50%	35-37°F	35 ,,	,,
Rye	——	33-35°F	24 ,,	,,

Gregory and Purvis have found that vernalization in rye can be effected even during ripening while the ears still remain attached to the plant by chilling them in ice-boxes (33-35°F) for 24 days and then allowing them to finish ripening as usual. Potatoes have been vernalized by Lysenko by suspending them on vertical wires for 20-30 days at 60°F under continuous artificial light. Similarly tomatoes re-

quire chilling of seeds for 24 days and then 12 days of continuous light.

Diagnosis of vernalized condition

The vernalized seeds are outwardly quite similar to the unvernalized ones but differ qualitatively from the latter. The precise nature of this qualitative change is not known. According to a few scientists enzymes are responsible for this change while according to others hormones are the causal agents. Both the theories have to a great extent been disproved. But there is no doubt that a change in the colloidal and chemical nature of the protoplasm takes place during vernalization as is proved by the fact that vernalized and unvernalized seeds react differently to certain stains. According to Richter the two kinds of seeds may be distinguished by the following methods of staining :- (*i*) by treating the embryo first with a 5% solution of ferric chloride for 2-3 minutes and then after washing by addition of a 5% solution of potassium ferrocyanide. Embryos from vernalized seeds are stained intense blue while those from unvernalized ones remain practically unstained. (*ii*) Another method is by applying a solution of methylene or toluidine blue having a suitable acidity. The lower skin (epidermis) of the leaf of a vernalized wheat appears blue while that of a nonvernalized one turns pink. In acid solutions (pH 3·8) of the latter stain the vernalized seeds quickly become blue while there is no stain in the unvernalized ones, but in alkaline solutions (pH 9·2) the unvernalized seeds stain more deeply.

Practical Utility of vernalization

The method is widely practised in Russia, which is predominantly an agricultural country with 83% of the population living in villages, and the gain to agriculture there from vernalization has been enormous. By this process winter cereals can be made to yield if sown in spring and in the spring varieties the great hastening of seed formation makes it possible to obtain two crops in the same season. The following table gives the time taken for flowering by some Russian varieties of wheat in both vernalized and unvernalized conditions.

Variety.		Date of Sowing.	Date of earing.	Number of days.
Spring varieties				
T. erythrospermum	unvern.	April 11th	June 1st	81
	vern.	April 11th	June 5th	55
Local "Girka" at Odessa	unvern.	April 11th	June 14th	64
Winter variety "Kooperatorka"	unvern.	Aug. 28th	Nov. 28th	92
	vern.	Aug.. 28th	Oct. 21st	54

The seeds after they are formed require some time to reach complete maturity. This period is greatly diminished (even to the 16th day after flowering) by vernalization. Winter wheats are generally harvested on the 38th day after the appearance of flowers. The germination of the vernalized grains if accomplished on the 16th day means a gain of 22 days and if the 10 days of after-harvest drying, which is not required now, be added, the gain is one month. Then we have to take into consideration the gain of about 20-30 days in the time from sowing till the production of flowers. Thus the total gain comes to about 2 months. The hastening of seed formation due to vernalization has made it possible to grow the high-yielding late varieties in dry regions like Ukraine where they are usually destroyed by heat and drought. In the vast tracts of land in the Arctic Circles the ground remains free from snow only for about 4 months in summer. Little agriculture is possible and the population lives mainly on saw-milling, hunting, and fishing, and is often forced to migrate southwards. Due to the great hastening of crop-production, successful cultivation, even in those countries, is now made possible. At Hibiny, the most northerly research station in the world, the Polar Division of the Institute of Plant Industry experimented with 3,500 varieties of wheat, 1,500 varieties of barley, and 500 varieties of oats in both vernalized and unvernalized conditions. 42% of the unvernalized varieties ripened and of the unvernalized ones about 15% did so, but it was both irregular and delayed. As a result of this experiment the number of varieties that can be

profitably grown in the Arctic regions have been increased by three times.

The yield from the vernalized plants is also much greater. At Odessa it has been found that in two varieties of wheat from outside the yield is 25 times more when vernalized and also it is much more than the best local variety grown normally. In the North Caucasus the late "durum" variety of wheat gave about 50% more grains both in 1932 and 1933 which were years of abnormal drought. Vernalization was not widely practised in Russia till 1932 when the area under vernalized crops was about 43, 000 hectares.* In 1933 it rose to about 200, 000 hectares and in 1934 the figures reached about one million hectares. The average increase in grain yield for the whole country was about 1·13 centners per hectare but generally it was about 2-4 centners. Not only the yield but other qualities such as drought resistance, size, quality, and weight of the grains are also increased as shown by the results obtained with all the varieties of the world collection of wheat. The milling and baking qualities are also much improved.

Short-day plants are difficult to grow in the long summer days but they grow very well even in summer if the seeds are vernalized or if the period of lighting be artificially shortened. The cultivation of the soyabean had been impracticable in Germany and England due to the long days prevalent when the plant grows. After vernalization they grow very well in summer and there is no need to grow them in warm green houses in the short days of winter. Many short-day cereals like sorghum, maize, etc., can now, for the first time, be easily grown under the long illumination of the northern regions and Arctic Zones.

Results with other crops have been equally encouraging. Thus in oats the increase in yield was 22%. The number of ears per sq. meter in vernalized ones was only 187. The vernalized plants were also about 4 inches higher. Rice in Holland showed earlier tillering (branching at the base) and the increase was 18% and 14% in the yield of grain and straw respectively. Potatoes in the Central Volga region gave the crop one month earlier and the yield was about 30-80 centners more per hectare. The results with cotton have been very remarkable. The plants were more vigorous and yielded more than those grown under the most favourable conditions. The Egyptian varieties gave the best results showing an increased yield of 78-157%. The American varieties gave less favourable results and probably required a slightly different technique. Not only the yield but the lint length and ginning percentage were both higher.

Ornamental and garden plants also respond to vernalization. Biennials flower in one year and by sowing annuals in spring it is possible to get an early display of flowers. The opposite effect, *i.e.*, delay in flower formation so that the size of the plant is increased, has also been obtained by withholding the conditions known to bring about vernalization. Thus cabbage, beet, lettuce, celery have been grown to big sizes by not allowing them to flower. The forage and the herbage crops show greatly increased growth in the first year and the effect is also seen in the second.

To plant breeders vernalization has been an invaluable asset. They can obtain even 3 generations of winter wheat and 4 of the spring variety in one year by vernalization combined with artificial control of the length of the day. They can now grow the early and late types, the winter and the spring varieties together, combine their desirable characters by crossing and get results quickly. The late variety of one district may not be always "late" in other districts and by actually crossing two desirable "late" varieties an ultra-early variety has been produced for another region. According to Lysenko "the strains should be sown both in the vernalized and unvernalized state. The best local strains should be crossed with those which after vernalization prove to be earliest and of best quality".

Not much work seems to have been done on the ability of vernalized plants to resist disease. Nemlienko showed that the frequency of the bunt disease, in which grains become filled with a greasy,

* 1 Hectare=2·471 acres.
1 Centner=110 lbs.

black mass strongly smelling of rotten fish, is in vernalized plants about one-third of that in unvernalized ones. According to Hanna, however, the incidence of a similar disease (smut) was not appreciably affected by vernalization.

Work in India or on Indian varieties

While the results obtained in Russia are so striking they are less encouraging in other countries under different climatic conditions or with other crops. According to Miss Purvis, there is no need to use expensive artificial refrigeration for the long-day cereals in England except to resow the patches damaged due to winter injuries with the same variety in spring so that the plants on the resown patches mature within a short time and yield the crop together with the rest of the field. The process can however be used with advantage there with short-day plants. In India the results so far have not been promising. At Pusa two varieties of wheat and barley were vernalized and sown. With wheat there was no difference in either yield or maturity from the unvernalized ones. Barley when vernalized for one week showed accelerated maturity but if done so for 2 weeks the maturity was retarded. Oats in either conditions showed an accelerated maturity of 1-6 days. At Nagpur work with cotton and sorghum gave no definite results but in some cases the latter showed an acceleration of 3-4 days in maturing. Rice seeds at Coimbatore remained unaffected. Probably the Indian forms require different sets of conditions and much work is needed to determine these. Once we are able to vernalize our plants properly there is no doubt that we can be more sure about the yield and regularity of our crops. In many parts of India rainfall is irregular and the summer often sets in too soon. Under such conditions one can easily imagine the great advantage of having the crop ready within a shorter period. This will save the plants from summer heat or drought due to the failure of rains. The Indian varieties, however, have yielded very encouraging results at the hands of the Russians. Flaksberger who in 1932 examined the world collection of wheats (6,300 varieties) reports marked response with winter wheats from India. The vernalized ones formed ears when the unvernalized ones did not even form the stem. With spring wheat, however, the differences were slight. The Indian wheats behave in the same manner as wheats from China, Japan, Jugoslavia, Morocco, Peru, North America, and a few other countries. In an experimental farm near Leningrad, in the Pusa 52 "graecum" variety the minimum reduction in the period up to flowering was 9 days. Under the continuous natural light of the polar region Indian barley when vernalized showed earing in 100% cases of which 44% ripened. In the unvernalized state only 22% eared and 2% reached the ripened state. The late Indian varieties of lentils showed an acceleration of 5-8 days. Their development was more rapid and the yield and weight of the grains were greater due to escape from summer drought.

Why plants get vernalized

Though the method of vernalization has secured great practical advantage to agriculture yet the principles involved are not yet fully understood. Lysenko's conceptions are as follows :—

(1) "Growth" and "development" are independent processes.

(2) In the life of a plant, there are a series of separate stages.

(3) These stages always proceed in a strict sequence and a subsequent stage cannot set in until the preceding stage has been completed.

(4) The separate stages require different conditions of their completion.

The difference in sense between "growth" and "development" should be clearly recognized. "Growth" means increase in size, but "development" means progress towards maturity and flowering. If winter cereals be sown in spring, they go on "growing" without limit and form numerous branches (tillers) but there is no sign of flowering, *i. e.*, they do not "develop". When they really "develop", a qualitative change takes place and flowers are produced. "Growth" and "development" cannot, however, be

completely separated. Purvis has shown that flowering can only be initiated after a minimal number of leaves are formed (*i. e.*, after a minimal "growth") and Klebs as long ago as 1918 showed that flowers can be formed only after the condition which he calls "ripeness to flower" is attained. In vernalization "growth" is arrested by the supply of a limited amount of water, so that "development" goes on and hence the plants mature early.

During "development" the plant passes through a chain of independent stages strictly following one another and each requiring different environmental conditions. The changes brought about in the plant is qualitative and there may be no visible external sign. Of the several stages that must be completed before flowering two are clearly defined. These are (1) *thermo-stage* in which temperature is the main factor. Winter wheat is generally sown in autumn when the temperature is low but if they are sown in the hotter spring the thermo-stage is not completed and the plants do not "develop", *i.e.*, remain indefinitely in the tillering stage. In vernalization the low temperature required to complete the thermo-stage is supplied and the plants can flower even in spring if other stages are also completed. (2) The next stage is called the *photo-stage* because the governing factor here is the length of illumination per day and temperature variations do not matter much. The long-day plants if grown in short periods of light fail to produce seeds. Completion of photo-stage requires first completion of the thermo-stage and then appropriate length of illumination, the intensity of light being of no consequence (artificial light of 5-10 foot candles is often sufficient). If winter wheats be sown in summer in the unvernalized state it will form no ears because the thermo-stage is not complete. If chilled but given only 10 hours of light per day it will also not flower because though the thermo-stage is complete the photo-stage is not so. But if the same plants be then transferred to the ordinary long days the photo-stage is completed and seeds will form. When both the stages are completed production of seeds will take place even if the plants are transferred back to high temperature and short illumination. Different varieties require different states to complete the stages. Long-day plants generally require a low temperature for the thermo-stage and long illumination for a definite period of days for the second stage. Short-day plants, on the other hand, require a higher temperature for the first stage and total darkness or short illumination for some days for the photo-stage. Vernalization therefore retards "growth" and completes these two "developmental" stages (or at least the first) even in the seed state. Once these stages are complete it does not matter under which conditions of temperature and light the plants are grown.

This remarkable theory of Lysenko, however, does not fit in all the known facts and some have opposed some of his ideas. Purvis has shown that if winter cereals be germinated at different temperatures the effect of the temperature is well marked if grown under long days but not so under short days. Others like Cailahjan, Vasiljev, Mckinney and Sando have proved that low temperature can be altogether dispensed with for production of flowers if during the first week of their growth winter cereals are subject to short periods of illumination. Therefore "Lysenko's idea of sequence of developmental stages may be right but the notion of strictly defined stages each independently related to some one factor of the environment" is contradicted.

According to Lysenko, vernalization is an irreversible process, but others have proved that the effect can be reversed. In soyabean a part of the stem was vernalized and flowers soon developed on that part but branches that originated from the treated part showed no effect of vernalization. Another vernalized plant flowered soon when kept in long days but after some time the effect was lost and it ceased flowering. Then after a period had elapsed it started flowering again as it would normally do under the conditions. Vernalized winter wheat seedlings have been found to lose their property when subjected to X-rays.

Accidents in Indian Coal Mines

(Continued from the last issue)

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Miscellaneous Sources of Accidents

Several cases on record show that instead of using the pass-bye road at the bottom of a winding shaft, persons attempted to cross the cage spaces of the shaft and were crushed beneath the descending cage. No doubt, these persons in most cases stepped into the cage space from the side which was opposite to the side on which the onsetter had been standing. I am of the opinion that a sort of movable fence in the form of chains hooked in the middle or in the form of rigid bar (as fitted in many cages) across the side opposite to the onsetter would cause the persons to take automatically the pass-bye road and would thus effectually prevent them from approaching closer to the shaft bottom from the opposite direction. Such fence, however, can be shifted easily for shunting tubs to and from the cages but not for persons to get on or off the cage on that side. All persons should enter and leave the cages from the side on which the onsetter is stationed. It has been recommended that provision should be made for convenient protected roads round the edges of shaft bottoms instead of or in addition to the usual pass-byes. One of the main reasons why persons attempt to cross the cage space appears to be that in so doing they will not have to travel the distance at which the bye-pass has been provided. If the pass-bye be provided round the edge of the shaft as recommended the workers cannot possibly find any objection to use it regularly.

Suffocation by Gases

The danger of black damp filtering into the workings from sealed-off fire-areas is not fully known to the subordinate supervising staff and the workers. The want of this knowledge has led to accidents. It is very important that knowledge should be imparted by actual demonstration or some other suitable means, to minimize the risk arising from this source. In addition to a safety lamp, it is advisable for the person examining fire-stoppings, behind which there is a fire, to carry an electric torch and to be accompanied by another person.

It has been recommended that before descending into a disused shaft, the simple precaution of lowering a light to test the condition of the air should be taken. It has been pointed out that acetylene lamps, although very serviceable in the detection of weaknesses in roofs and sides by their powerful light, go on burning in an atmosphere which will not support life.

Suffocation by Explosives

A large number of persons are injured or killed every year by explosives. It is therefore essential that the management should see that all possible precautions are taken to prevent the danger. Many shot-firers know very little of the regulations regarding explosives, although as a matter of practice they may not be violating them to any serious extent. In some collieries, nearly all C. P. miners are issued authorizations as shot-firers. Where there are hundreds of such authorized shot-firers, there is reasonable doubt if the management devotes the necessary time to acquaint thoroughly these persons with the regulations concerning their duties. This remissness transpires from time to time, especially after an accident. Only such number of competent shot-firers should be appointed as would be able to carry on blasting operation efficiently in each mine; only a few relieving hands, depending on the size of the mine, may be necessary. In the usual authorization letters it is written "...A copy of the regulations is handed over to you for your information";

but as a matter of fact, few colliery companies do actually issue spare copies to be handed over to the authorized persons at the time of their appointments. The supervising staff too do not generally take the trouble of copying out the regulations for the benefit of the persons employed. Now that abstracts of the Act, Regulations, and Rules, and also Bye-laws have been translated into the vernaculars, the managers of various collieries will be well advised to procure and distribute them to the authorized persons who should be asked to recapitulate and explain what they have understood. An alleged apathy on their part is very often put forward to meet this suggestion. But if the manager of a mine makes it a point not to appoint any person to hold a responsible position until or unless he is thoroughly conversant with the regulations and bye-laws relating to his duties, he will find that his staff will take proper care to learn them by heart.

The principal causes which lead to this class of accidents may be traced as follows :-

Smoking near explosives : If the shot-firer and his assistant who carries the explosives do not keep in their possession any *biri* or smoking apparatus while on duty, many accidents would be avoided. They may be supplied with magnetically locked safety lamps, some suitable type of enclosed lamps or preferably, with electric torches for underground use. When ready to set fire to the shots in a non-gassy mine, the shot-firer can always borrow an open light from a workman for the purpose. It would then be possible to make it compulsory that no person while in the neighbourhood of a magazine or carrying a tin containing explosives or being actually in possession of explosives shall keep an open light, match-box, or smoking apparatus of any description with or near him. A severe punishment for the breach of this order will be sufficient to enforce it effectively.

A large number of persons have lost their lives through the carelessness of their fellow-workers who, perhaps unintentionally, threw a burning match-stick on explosives. A C. P. miner leaves his tin of explosives in any part of the gallery and sometimes his fellow-worker from a neighbouring gallery comes for a friendly talk with him, perhaps sits close to the tin and enjoys his *biri* while engaged in conversation. In order to ensure safety in such a case, suitable recesses may be cut in the pillars and the tins kept there during working hours. Canisters with hinged lids and locking arrangements should be provided for carrying gunpowder to and from the mine. A case is known when a shot-firer neglected to re-attach the lid of a tin of gunpowder and inadvertently set fire to the contents with his own open light.

Keeping or drying powder near open fire : This has caused accidental ignition of the powder resulting in the loss of some lives. Those collieries which have provided suitable steam-drying rooms accessible to authorized persons only while on duty in compliance with the recommendations of the Mines Department no longer apprehend any danger from this source. It has been advised that where gunpowder is stored or dried in an artificially heated building written orders should be issued prohibiting the keeping of any explosive other than gunpowder in the building. It has also been recommended that the dwellings of miners should be searched from time to time to see if gunpowder has been stored therein.

Use of iron rods in tamping the charges : In some mines it has been found that though there are many shot-firers there are but few tamping rods made of copper or brass. If the management check the tools provided with the number of persons using them, this defect may be brought to light and remedied. In some collieries both the ends of crow-bars are bevelled off so that the rounded ends may not be used for tamping the charges of shot holes. This simple device may be introduced in all other collieries with advantage.

Insufficient warning before blasting : A casual warning has failed in many cases to attract the attention of the general body of workers who inadvertently entered the danger zone and met with accidents. Warning of an unmistakable character should be given and the supervising staff should occasionally be satisfied that such warning is actually being given by the shot-firers.

The manager should provide a few bamboos, specially painted red, for the use of shot-firers. Where there are many roads leading to a place of blasting, the shot-firer shall fence off all approaches with those bamboos, leaving out one only for his own exit after setting fire to the shots. After the blasting, he must examine the place and satisfy himself that it is safe for resumption of normal work and then proceed to remove the temporary fences described above. Thus, the danger of workers suddenly coming in the way of the blasted prices of coal or entering into the gallery before the blasted roof and sides have been dressed down and made safe will be eliminated.

Fuses of insufficient length: Some shot-firers are in the habit of attaching the same length of fuse to all shot-holes irrespective of the distance they have to travel in order to reach a place of safety after setting fire to the shot-holes. This is due to their ignorance of the rate at which fire travels in a fuse. This knowledge can easily be imparted by explanation and demonstration. The accidents to shot-firers due to their return to the gallery while the shot is still hanging fire may also be avoided if they clearly understand how slowly fire travels in a fuse and hence how long they ought to wait. If suitable fences are erected or the approaches to the place of misfire properly guarded, accidents due to men inadvertently entering such place may be avoided. The regulations insist on these precautions and accidents have occurred only when they were not observed.

Firing too many shots at a time: This practice sometimes led to confusion as to the correct number of shots that have actually been fired. The persons in charge of blasting operations thinking that all the shots had gone off entered the gallery and met with accidents by the unexpected explosion of one of the shots that had hung fire. It has therefore been recommended that a large number of shots should not be fired at a time. When this is necessary, it is better to fire them simultaneously by electrical means.

'Blown-out' shots are known to have caused coal-dust and fire-damp explosions with a large number of fatalities. In order to minimize such cases, the shot-holes should be properly placed, drilled to the proper depths, and charged properly with the requisite amount of explosive.

Attempt to remove the detonators and fuses, by scrapping out the tamping from misfired shot-holes, has caused many accidents; perhaps this is the chief source of accidents by explosives. Through sheer ignorance of the danger attempts appear to be made to withdraw a misfired charge or to redrill into a misfired hole containing the charge. In many mines the miners drill the holes and are cleared out of the place when the shot-firer blasts the holes. They return to see the effect of the blasting but are generally ignorant of the substances that bring about the effect. Thus they gradually become curious and tamper with the charges whenever they find an opportunity of doing so. If the miners are given demonstrations, in batches, of the use and misuse of explosives and of the danger involved, surely they will not lay their hands on missed holes as they now unhesitatingly do without any knowledge about it. Many persons who were injured by explosives have admitted that their ignorance of the substance and their curiosity were responsible for the accident and that if they had known the substances to be dangerous they would never have tampered with them.

Again, having had knowledge of the explosive substances, the miners would readily be able to detect misfired holes or charges near their working places which by chance remained undetected by the shot-firer. Thus, they would avoid drilling into such holes but report the fact to the supervising staff instead.

In the process of charging a shot-hole with loose gunpowder, the spilling of some powder on an open light which had been held near the hole caused an ignition of the powder. It has therefore been recommended that an open lamp should be kept at least 15 feet away from the hole that is being charged. If the shot-firer is provided with an electric torch, he will have no more need of an open lamp and will be able to charge the hole more efficiently and with

perfect safety. If gunpowder be used in cartridge form, there will be no risk of spilling of powder in the process of charging. Moreover, the cartridges will help the powder to keep dry.

Irruption of water

In his paper on "Accidents in Indian Mines and Mining Legislation" Mr Simpson has remarked that the chief source of this class of accidents is heavy rainfall causing the flooding of streams and rivers and the bursting of embankments. When this takes place, the entrances of mines may be submerged or the weight of flood water may break down the surface overlying the mine workings. In either case the workings are speedily inundated, sometimes with loss of life. He has made the following preventive recommendations :—

(*i*) Refraining from the extension of workings under areas where the cover is weak and insufficient.

(*ii*) Siting mine entrances on high ground above flood level.

(*iii*) Providing artificial protection such as walls or embankments of sufficient strength.

(*iv*) Interfering as little as possible with natural surface drainage, and where it is necessary to do so, providing culverts of ample dimensions.

(*v*) Withdrawal of workpeople at the time of abnormal rainfall from workings where there is any possibility of inundation.

Positions of all streams, 'Jores', large tanks, etc., should be most accurately surveyed and marked on the mine plans as required by the regulations. While working below a waterlogged seam all connecting places between the two workings should be carefully examined and the pressure of water noted at regular intervals. Depillaring in proximity to waterlogged areas, streams, etc., is to be avoided. "As it is important to avoid fracture of the strata and subsidence of the surface, the pillars are to be extracted on a system by which the excavations are filled by hydraulic packing."

For mines which are liable to inundation owing to the entrances being below the flood level, the Mines Department recommend that there be no night-shift work during the monsoon. A "danger pillar" should be fixed with a red mark, which must be at least 8′ below the highest flood level of the river, Jore, etc., and all persons should be withdrawn from the mine when the water reaches the mark.

The compulsory minimum barrier to be left against a neighbouring mine would go a long way towards prevention of irruption of water from that mine.

Sometimes the water-dams are subjected to more pressure than they were originally meant to withstand ; the result is a sudden bursting and the consequent danger from flooding. All water-dams should de regularly examined and reinforced and details of plans and sections of dams showing the dimensions and the depth to which the dams are cut into the roof, floor and sides should be shown on the mine plans. The materials used in the construction of the dams should also be stated. It has further been recommended that where a lower seam has been abandoned and there is a possibility of that seam becoming filled with water a well designed and properly constructed dam should be built in the shaft capable of sustaining the maximum head to which the water can attain.

"Avoidance of accidents due to unintentional connection with the workings of waterlogged mines calls for strict accuracy in surveying and the careful observance of the rules laid down for procedure when workings are approaching old waterlogged workings". (R. R. Simpson.)

Haulage

A large number of haulage accidents occur to persons lying down on or near the haulage roads. It is seen daily in many mines that the supervising staff generally overlook this dangerous practice. If they seriously think of stopping it there cannot be much difficulty in the way.

The majority of persons injured or killed on the haulage roads are persons who are not employed in haulage operations. Why then are they found on or near the haulage roads ? It appears that in many mines the tubs are lowered down the pits when the miners go down. The miners do not also proceed to their working places until they can make sure

that they are going to get tubs for loading. Thus, there is always a big crowd at the bottom of the winding pits attended with the risk of somebody being run over by the moving tubs. The miners cannot be persuaded easily to stay at a safe distance from the pit bottom for the simple reason that they are under the notion that unless they rush for a tub immediately on its arrival at the pit bottom either they may have to wait indefinitely or they may not get any tub at all. If the tubs are allotted systematically and justly, there will be no occasion for congestion at the pit bottom. Where the trammers supply empties to the miners, the latter would not hesitate to go straight to the working places for their allotted tubs there. If this system is introduced it will not only ensure safety but at the same time encourage miners to turn up as early as possible. In order to facilitate the distribution, the tubs should be numbered. Another advantage in numbering the tubs is the assurance that a thorough examination of tubs under Bye-law 64 will be made, as the examiner must report the state of each tub, mentioning its serial number.

By providing a side gallery in the immediate vicinity of the pit bottom the miners may be induced to halt there. I would also like to draw the attention of the management to the circular of the late Chief Inspector of Mines wherein he advised white-washing a 2-feet wide space on the roof and the sides of the landing, at a distance of 20 feet from the main line crossing so as to demarcate the safe halting places for miners and loaders.

It has been suggested that the practice of run-riding by haulage hands on trains while proceeding at a speed higher than three miles per hour should be prohibited. Riding on tubs in motion is a dangerous practice. If the manager finds it necessary, he should appoint in writing such persons only as he considers thoroughly competent for the purpose; such an appointment should however be resorted to on as few occasions as possible. The authorized person should carry a special token, issued by the manager, for identification.

The practice of the trammers guiding a train of tubs round sharp curves by suspending themselves on the sides of tubs should be stopped and where necessary, guide rails should be provided instead.

When miners hand-shunt tubs on tram-lines, they seldom give warning to anybody. The danger arising from this neglect, especially while they turn round curves, should be pointed out to them. They should also be advised to hang their lamps at the corner of the tubs in such a manner that people on the opposite side may readily notice the approaching tubs. On endless haulage roads it is difficult for persons walking along them to ascertain whether a train of tubs is approaching from the opposite direction. In some mines a haulage hand walks with the train with a light as a precaution. But there are others where this precaution is not taken. It is desirable that in such mines at least a suitable type of lamp (one on each train) should be affixed to the front. The lamps will go forwards and backwards and hence can be used over and over again.

Written orders should be issued to all trammers and shunters of tubs to the effect that they must maintain a clear space of at least 15 feet between two moving tubs. Also, they must stop further shunting of a tub if any person is found walking on or along the tram-line within 15 feet of the tub.

There were several accidents in the past by runaway tubs due to draw-bars breaking, or tubs becoming uncoupled by a jerk. The examination of draw-bars, coupling hooks, etc., has therefore been made compulsory and it is hoped that this class of accident will be brought down to a minimum. It has been suggested that draw-bars made of wrought iron of high quality should be used. In order to ensure operation in time of need, only a suitable type of drag should be used. By judicious fixing of blocks on the haulage roads, runaway tubs may be arrested and thus many lives saved.

On steep inclines, the use of a ram's horn type of coupling hook, snap hook or specially constructed D link type of attachment for tubs and also, inter-locked stopblock of runaway switches has been recommended by the Mines Department. More care

should be taken in some collieries in selecting the type of coupling and in attaching the same to the haulage rope and also, in fixing the back-stays behind the loaded sets.

The practice to leave tubs standing on slopes with pieces of coal placed underneath the wheels should be strictly forbidden and a sufficient number of sprags of a suitable type should be kept in readiness for use on all haulage roads.

Owing to the faulty alignment of the haulage roads and the curve pulleys, the ropes sometimes slip off violently and may hit anybody who is in the vicinity. This defective alignment can easily be detected and set right. By providing curve pulleys with sufficiently wide flanges, the risk of rope slipping is minimized.

Cleaning and oiling of friction rollers should be prohibited while the rope is in motion. The practice of bringing the rope back to the friction rollers or curve pulleys by hand should be stopped and a suitable type of hook provided for the purpose.

Another dangerous practice of the hookmen is the way they uncouple the haulage rope from the train immediately on arrival of the latter on top landing and before the train stops. They should either be ordered to wait till the train stops or some suitable type of hook given to them for uncoupling the train from a safe distance.

For rerailing tubs, suitable poles should be provided and their use enforced. The haulage-hands are in the habit of using no pole at all or any timber they come across near the place of a derailment and thus sometimes endanger themselves by using too short a pole.

For want of a sufficient number of friction rollers or by prolonged use, the haulage ropes in some mines wear out considerably but are not replaced until they are knotted in several places. By using such ropes the management simply invite trouble and accidents.

It is very desirable that underground landings should be strongly illuminated. This is done in collieries equipped with electricity but not in others. The use of a few strong lights (petromax, etc.) in the latter mines would enhance safety to a considerable extent. Where strong lights are provided, accidents due to one hand-shunter's tub overtaking another seldom occur.

Wherever possible separate travelling roads for workers should be provided and their use enforced.

Underground Machinery

The majority of these accidents are due to persons falling upon the bars and chains of coal-cutters while in motion. This class of accident may increase with the increased use of coal-cutting machine unless due precautions are taken.

The practice of holding the anchor stay till the strain is on should be discouraged and a sufficiently deep hole should be cut into the roof for the purpose. It has often been recommended that persons working coal-cutters should not stand near the cutting bars or chains when they are in motion.

It should be made compulsory for all persons handling any machinery in or about the mine to wear tight and not loose clothing. This is enforced in some mines and should be universally introduced. Some mine-owners will probably have to provide a few overalls ; but they will not mind the little additional expenditure in consideration of the extra amount of safety thereby ensured.

Some accidents have occurred to pump attendants, haulage engine drivers, etc., who, while standing or working near the plants, accidently fell on the moving parts and were injured. If the fences round the moving parts are erected in a substantial manner and not in a perfunctory way, as is noticed in some cases, these accidents will not occur.

In some cases the attendants of engines, etc., were found to be working inside the fences which were supposed to protect them.

Strict orders should be issued to all concerned that before proceeding to examine any part of a working machinery, they should stop the same.

Sundries underground

Some of the principal causes of this type of accident are :—

(*i*) Slippery travelling roads.

(*ii*) Improper setting of props as may cause a prop to fall on a person.

Sometimes the rolling pieces of stone from a goaf-edge cause one or two props to be knocked out from the first row set against the goaf. When these props are free to move, they fall on the workers, killing them often instantaneously. In order to guard against this danger, I have always suggested that the 1st row of props should be tied together by a length of wire passing round each of them.

(*iii*) Neglect to set a ladder firmly on the ground before using the same for dressing the roof or sides. Thus, if they somehow loose balance, the dressers fall down and sustain serious injuries. If the subordinate supervising staff are instructed to keep an eye on this matter, the ladders will not be set in a careless manner. These supervisors should also see that before a miner proceeds to work on the side of a fairly high gallery, he must arrange for a suitable platform.

(*iv*) Some carriers carry loads too heavy for them with the result that their loads sometimes fall on themselves inflicting injuries. If the supervising staff take these persons severely to task whenever they notice this practice in any part of the workings, it will soon come to an end.

(*v*) In removing the overburden from the edge of a quarry, the workers may avoid the risk of slipping or overbalancing if they maintain a ledge, say, 3 feet wide along the edge of the cutting. The height of this ledge may be maintained, say, 3½ feet *i. e.*, as the bench is the lowered, the ledge will also be cut down maintaining only 3½ feet height all the time. The use of safety ropes should be made compulsory for persons working on the slope of a quarry.

(*vi*) Travelling in the mine without a light. This is done by miners for economizing oil consumption. If the miner is questioned why he does so, his reply invariably is that the oil supplied is not sufficient for the work. The management will of course say that the miner wants to save the oil for burning in his own quarters. Whatever may be the case the supervising staff should not permit anybody to work or travel in the mine without a light.

(*vii*) Even for light jobs on the surface in some departments, the applicant is medically examined as to his fitness, but it is regrettable that in a strenuous work like mining no such examination is made. Any new recruit may be employed too readily. The result is that sometimes persons subject to epileptic fits or other diseases get jobs and may later on bring about an accident not only to themselves but to others as well. It is advisable therefore that all new hands should be thoroughly examined by the colliery doctor who should report about their physical fitness to the manager.

By Surface Machinery

Many accidents of this description were due to persons wearing loose clothing while attending the machinery. As already suggested, the use of overalls by persons attending any machinery should be made compulsory. All moving parts, including the shaft of a machinery, should be guarded.

In the year 1927 two persons took shelter inside the drums of haulage and winding engines; they lost their lives when the engines were started. "If convenient shelter had been provided the accidents would not have occurred."

Wherever possible, the oiling of moving parts should be done when the machine is standing idle. If it works continuously, arrangements which would enable oiling to be done from outside the fence (such as by means of a funnel and a long pipe) should be provided.

It has already been suggested that the fencing of surface machinery should be such as not only to guard against normal risks but also, as far as possible, against carelessness, ignorance, and disobedience of workmen.

By Surface Railways and Tramways

The practice of trammers, loaders, etc., of passing between two moving or one stationary and another moving tubs has led to many accidents. The next important cause is unauthorized riding on moving tubs. These practices can be completely stopped

if the supervising staff take strong action and not a light view of it, when they come across any offender.

In hand-shunting tubs on sloping lines care should be taken to see that the tubs are moved at suitable intervals so that one shunter may not be overtaken by the tub following. Loose shunting of wagons on railway lines should be discouraged, and in hand-shunting the wagons under the supervision of a responsible male person, a liberal use of the brake should be made either by himself or by a competent person deputed by him. Pushing should only be done from behind and only one wagon at a time should be moved.

By Electricity

It is satisfactory to note that the number of cases are few, although the use of electricity in mining is increasing year after year.

A few accidents occurred on account of damaged trailing cables not being repaired properly and vulcanized. Frequent testing of the insulation of cables is necessary. Faulty earthing of electric apparatus, if left undetected, may lead to accidents.

Men climbed towers carrying high-volt transmission line with the object of getting bird's nests and coming into contact with the live conductors they were killed instantly. Substantial barbed wire fences round the tower-base might put a stop to this practice. It would be advisable to switch off the current and destroy the nest when found on the towers.

It has been pointed out that with imperfect contact between current-carrying parts an explosion in the oil switch can occur even if the switch contacts are immersed in oil, and further that an oil switch, the power of which to withstand successfully an internal explosion has not been tested, is a potential danger in any place where there is a risk of the presence of inflammable gas. Also that in the design of flame-proof apparatus, large openings in the casings, even when they are covered by reinforced plate glass, should be avoided.

It has further been pointed out that a shock from a circuit at 100 volts only has been known to cause death. The circumstances favourable to a fatal shock at a low pressure would seem to include the following :—

(*a*) a moist state of skin,

(*b*) a large area of contact,

and (*c*) a considerable length of time during which the person remains in contact.

All these conditions can be obtained in mines where persons wearing the minimum of clothing work in a moist atmosphere in isolated situations.

Subsidence Of Surface

This is principally caused by the extraction of pillars from shallow depths. If the area which is going to collapse as a result of the extraction of pillars is kept fenced and all buildings vacated and demolished beforehand, no loss of life is likely to occur from such subsidence. But, sometimes when this precaution is not taken before commencing the extractions, the safety of persons may be threatened.

Then again, the excessive width of galleries or pillar robbing may cause a sudden collapse and thus lead to accidents. Sometimes the pillars in old workings crush down or weather to such an extent that the surface buildings, etc., are endangered. The regular inspection of old workings has therefore been recommended and is being carried out at a number of mines at present.

Boiler Tanks

Many children have lost their lives as a result of drowning in boiler feed tanks. If the tanks are kept substantially fenced, by walls not less than 3'6" high, or by some other means, this class of accident will be stopped altogether. The accumulation of ashes near the walling of such tanks reduces the effective height of the walls and should not therefore be allowed.

General Remarks

It has already been pointed out that a long period of work in responsible duty may lead to forgetfulness. The management should therefore

see that no member of the supervising staff is made to work for a long period unless there is special reason justifying such employment.

It is an acknowledged fact that with the education of the miners the general state of things would improve considerably. The labourers in Indian coal mines are, generally speaking, illiterate and less intelligent than their fellow workers abroad. But the colliery-owners and managers in this country have got no alternative but to employ such type of labourers in their mines. Under these circumstances endeavours should be made to make them more useful by education. Is it not preferable to spend a small amount each year towards the intellectual development of the labour force?

In his annual report for the year 1926, the Chief Inspector of Mines in India wrote; "In other countries the work of Safety First Organizations has enabled certain mining companies to obtain considerable reductions in the rates of insurance against accidents. The smaller number of claims for compensation on account of fewer cases of accidents would justify such expenditure even in these hard times." According to the Chief Inspector of Mines in India, most of the labourers in Indian mines are illiterate and ignorant men to whom ideas of discipline are something new and difficult to comprehend. They are, however, amenable to discipline, and it is one of the most important duties of a manager to train the labourers in "safety first" principles, both by personal example and through subordinates.

Much could be done in the way of education of the labourers by the formation of a committee which could be provided with a motor-car equipped with apparatus and moving pictures for demonstration purposes. The committee could divide the coal fields into suitable groups and arrange periodical visits. The pictures should demonstrate to the workers the right way of performing various mining operations as also the consequences of wrong methods, the various "safety first" methods, sanitation, etc., photos taken after accidents may be demonstrated. "Safety first" posters may also be exhibited in various conspicuous places in or about the mines.

The next move may be the opening of schools for the children of miners in various centres. The employment of children in mines is now prohibited but it is a pity that these children are left loitering about and very few facilities have so far been given to them for the improvement of their mental faculties.

Owing to the heartless treatment of some of the colliery doctors in the past many miners are prejudiced against them. Thus, even simple cases of injuries are known to have turned fatal for want of timely or proper medical treatment. A sympathetic attitude on the part of the doctors would remove regrettable state of things.

It has been suggested by the Chief Inspector of Mines in India that it would in the long run pay colliery-owners to provide their workmen with boots.

It has been found in the past that a labourer or even a person holding a position of trust in a mine after committing an offence under the Indian Mines Act which leads to an accident absconds from the mine and finds ready employment in a neighbouring one. Here too he may commit a similar offence costing the lives of some work-persons. The records maintained by many collieries are found to be insufficient for the tracing of offenders and for proving their identification. To secure these objects all particulars of each person employed in or about a mine should be obtained from as many sources as are available and a full history together with his thumb impression and a certificate of fitness recorded in a register specially kept for the purpose; if possible, a photo also should be kept.

It is pleasing to note that the remarks embodied in these pages are not applicable to all mines, otherwise there would have been many more accidents and loss of lives.

It will appear from the foregoing notes that although the colliery managers and their staff are doing their best to prevent accidents, there are many other means which may be effectively adopted for the furtherance of this object.

Although the suggestions are the outcome of a close personal touch with Indian labourers, I do not expect that everyone of them would find favour with the managers. No doubt "accidents are accidents", as many people would say; but there are several things which could be done to minimize if not to stop them. Therefore, if the acceptance of any of these suggestions saves even a single life, I will consider my labour well repaid.*

TABLE No. II

Showing classification of the causes of the accidents which occurred during the period 1925--29.

YEAR	Misadventure		Fault of Deceased.		Fault of Fellow Workmen		Fault of Subordinate Officials.		Fault of Management.		Faulty Material.	
	No. of accidents.	Percentage of total No. of F/As.	No. of accidents	Percentage of total No. of F/As.	No. of accidents.	Percentage of total No. of F/As.	No. of accidents.	Percentage of total No. of F/As.	No. of accidents.	Percentage of total No. of F/As.	No. of accidents.	Percentage of total No. of F/As.
1925	122	61.00	39	19.50	8	4.00	15	7.50	15	7.50	1	0.50
1926	144	57.58	41	20.70	13	6.51	16	8.06	12	6.06	2	1.01
1927	131	62.68	45	21.53	7	3.35	14	6.70	12	5.74	-	---
1928	147	66.52	39	17.65	9	4.07	12	5.43	13	5.88	1	0.45
1929	146	68.87	43	20.28	8	3.77	5	2.36	9	4.25	1	0.47

* From a paper read before the National Association of Colliery Managers, India, dated March 12, 1937.

The Aetiology of Epidemic Dropsy (Beri-Beri)

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THOUGH little known outside its endemic home, epidemic dropsy is a major public-health problem in the eastern provinces of India. In Bengal the disease is widely distributed. Hospital records alone show that during the last 11 years (1925-1935) the disease (beri-beri – popular name for epidemic dropsy) was prevalent in all the districts of Bengal. The annual incidence, according to these records, amongst the hospital patients averaged 7,199 during this period.

Epidemic dropsy first attracted attention more than 70 years ago. Since then quite a volume of literature has accumulatad on the subject, a survey of which brings out three important theories with regard to its aetiology, from amongst a multitude of theories. Each of these theories claims a large number of ardent adherents. These are :

(1) 'Diseased' rice theory.
(2) Contagion theory.
(3) Mustard-oil theory.

The last two theories are vague and ill defined, but the first theory has been elaborately worked out and at present claims official acceptance. However, none of these theories afford satisfactory explanation of all the observed facts. Field investigations were, therefore, undertaken in seven different localities representing rural, semi-rural, urban, and industrial areas, and information was obtained in respect of 961 patients, 2581 healthy persons, 310 affected and 390 unaffected families. In addition certain relevant data were collected from 1727 unaffected families having 9678 members. Critical analysis of these data failed to support either the 'diseased' rice theory or the contagion theory and gave strongly suggestive evidence in favour of the hypothesis that certain consignments of mustard oil contained a deleterious substance, the nature and origin of which were unknown, and that the ingestion of such oil was responsible for the disease. Experiments were carried out to test the validity of this hypothesis as well as of the other two theories. Since animal experiments have failed to yield definite results, it was decided to carry out human experiments under strictly controlled conditions.

The contagion theory was tested in a small semi-isolated community. The beds of sick persons were arranged in between those of healthy persons. The two groups messed separately. The healthy persons were carefully watched for a long period to discover if any of them developed symptoms resembling epidemic dropsy. The results were entirely negative.

Feeding experiments on human volunteers living in an institution under strictly controlled condition were also carried out. Altogether three experiments were performed in each of which 12 volunteers were employed. In the first two experiments, the volunteers were divided into four equal groups as given below :

Group I received 'diseased' rice and 'suspected' (on epidemiological grounds) mustard oil.

Group II was fed on 'diseased' rice and jail-produced mustard oil.

Group III was given 'healthy' rice and the 'suspected' mustard oil.

Group IV was put on 'healthy' rice and jail-produced mustard oil.

Except with regard to the differences, the food given to all the groups was exactly the same, and

resembled in quantity and quality the usual Bengalee food.

The results of the first two experiments were inconclusive. In the second experiment in which 'suspected' oil from different sources was given two, possibly three cases of epidemic dropsy developed, amongst the 'suspected' oil group. But the role of 'diseased' rice as an associated factor could not be excluded. In the third experiment in which diseased rice was entirely eliminated all the six persons taking 'suspected' mustard oil developed signs and symptoms identical with epidemic dropsy, while the other six who used the jail-produced oil remained hale and hearty.

The conclusion drawn from the field studies and the experiments described above is that epidemic dropsy is caused by the ingestion of a poisonous substance or substances conveyed through the agency of mustard oil. The nature and origin of these substances is not yet known, nor is it known whether the term 'epidemic dropsy' connotes a single pathological entity or covers a number of different aetiological conditions closely resembling each other in their clinical manifestations.

While for the applications of effective control measures it is necessary to clear up these points, much can be achieved on the basis of the results presented here, in the way of prevention of the spread of the disease and of the development of serious symptoms.

Further investigations are in progress.

The Yellow Fever Menace

In the May issue of the *Journal of the Indian Medical Association* has been published an interesting article on the control of stegomyia mosquitoes in Calcutta with special reference to yellow fever and dengue. "It is admitted by all that the virus of yellow fever in absent is India at present, but the conditions of its spread, if introduced, are favourable in the highest degree." Aeroplanes are in this respect a great menace, and "it would appear to be a matter of common prudence to forbid the flight of aeroplanes from West Africa to any place where yellow fever is capable of becoming established. In view of the gravity of the situation, it would be still better to prohibit the entry of aeroplanes to all areas which are suspected of being foci of yellow fever. The slight interference with trade or travel is of small consequence when compared to the danger of spreading the disease." The Government of India have therefore recently made certain regulations under the Epidemic Diseases Act of 1897 prohibiting entrance into India, of persons, within nine days of their being in an area in which yellow fever exists or is suspected to exist, and of aircraft starting from or alighting in any such area. In Calcutta the stegomyia-index was found to be high enough to cause serious concern to the authorities and such as can hardly be passed over lightly. In America this disease has been effectively controlled by suitable anti-mosquito measures, and similar steps must be taken in this country to combat it.

Notes and News

Medical Research in India

The annual report of the Scientific Advisory Board of the Indian Research Fund Association, on medical researches conducted under the aegis of the Association, during the year 1936, has just been published. Amongst the subjects that received the attention of the research workers during the year, mention may be made of cholera, anti malarial drugs, malaria transmission, black-water fever, nutrition, leprosy, plague, anti-rabic vaccine, tuberculosis, indigenous drugs, maternal mortality, drug addiction, cancer, typhus, snake venoms, epidemic dropsy and kala-azar, and the problems presented by each were investigated in their different aspects with particular reference to Indian conditions.

The epidemic dropsy had two main lines of work: (i) the study of patients suffering from epidemic dropsy, and (ii) a search for evidence implicating rice or other articles in the causation of the disease. The results obtained so far indicate that there is some infective agent in the causation of epidemic dropsy and that the infective process exhibits in the initial stages varying degrees of intestinal disturbances leading, in the majority of patients, to a change in the intestinal bacteriological flora. A study of rice samples was made in the laboratory and in the field. The results so far obtained suggest some etiological connection of rice with the disease. A more detailed study of the opacities in rice grains points to the existence of two causative factors; a transmissible plant virus which leads to a later invasion of the damaged grain by soil bacteria.

In addition two field investigations were carried out, one at the Twenty Lines tea garden in Assam and the other at Jamshedpur, Bihar. The data collected at these investigations, together with those obtained at previous investigations, were analysed with a view primarily to test the validity or otherwise of the three important theories of epidemic dropsy, namely (i) the rice theory, (ii) the mustard oil intoxication theory, and (iii) the contact infection theory. The object of these enquiries was to narrow down the issue if possible and indicate the lines along which more exact work might proceed with advantage. General observations made at the investigation show that two factors closely associated with incidence are age and economic status. Babies in arms entirely escape, toddlers are only exceptionally attacked, young children are only mildly affected, those in the prime of life suffer worst, and the incidence again tends to drop with advance in age. Again, it has been found that epidemic dropsy is chiefly a disease of the middle classes, and that Bengalis and others who have adopted their habits of living are the worst sufferers. This was demonstrated in a certain part of Calcutta where Bengalis and non Bengalis of more or less the same economic status lived side by side.

At the places where investigation was conducted, handpounded rice was in common use in villages and small towns, but in bigger cities where the grain is imported, milled rice was largely consumed. Outbreaks of epidemic dropsy were as severe amongst communities consuming parboiled and milled rice as in those used to sun-dried and hand pounded grains. Those processes, it is accordingly concluded, are therefore of no significance in the causation of epidemic dropsy. Conditions of storage of rice were found satisfactory in all places visited. In certain communities each household was found to gather and store its own grain. If infected rice is to be blamed for the causation of the disease, simultaneous infection of a large number of unconnected stores has to be assumed. In other places also, it was not possible to connect different cases to a common source of rice supply. It is unlikely, says the Report, that a water-souble toxin elaborated in "infected" rice has anything to do with the etiology of epidemic dropsy, because those who habitually threw away water in which the rice is boiled were found to suffer much more than who did not. It has also been found that while the throwing away of rice-water does not afford any safeguard against the occurrence of the disease, other factors common to the members of the family are of importance.

NOTES AND NEWS

No case, says the Report, was seen among the non-consumers of mustard oil, but the interpretation of the data is complicated by a number of associated factors of which the lack of controls, due to universality of its use, and the complications introduced by admixtures which the oil undergoes during its distribution to the consumers are the most important. The investigation at Calcutta, however, showed that the low incidence among non-Bengalis was associated with smaller consumption of mustard oil. Again, among two groups, Bengalis and non-Bengalis, the incidence of epidemic dropsy cases rose with a corresponding increase in the quantity of oil consumed. It has however been found that there is a difference in the morbidity rate in the Bengali and non-Bengali communities when consumption of the oil is the same, and this it is difficult to explain on the basis of the oil theory. Investigations at Jamshedpur yielded suggestive evidence with regard to the "mustard oil theory". Jamshedpur has a population of about 100,000 composed of people from all the different Provinces of India, and a small number of non-Indians. One hundred and eighty five cases occurred among 52 Bengali families and 37 cases in 14 non-Bengali families. The use of a particular brand of mustard oil, obtained from a local mill supplied within a short period before the commencement of the outbreak, was a common feature in a large majority of the affected families. This problem however can not yet be said to have been solved.

As for the infection theory, it was found that contact with cases did increase liability to the disease and this liability increased with the intimacy of contact. But this finding was complicated by the fact that intimate family contact went hand in hand with the consumption of a common diet. On subjecting the data to elaborate statistical analysis, it was found that with a decrease in "congestion", that is, with an increase in the number of rooms per head in a family, there was a corresponding rise in the development of secondary cases in the affected families. This finding, says the report, it is difficult to reconcile with the contact infection theory.

A statistical enquiry into the cases of maternal mortality and morbidity in child birth in India, is also being carried on in Calcutta and the Added Areas, divided into 32 wards. The intention is to investigate every female death associated with pregnancy, child birth and the puerperium for the period of one year. During the period June 15 to October 15, 355 probable maternal deaths were followed up. Three hundred of these deaths were maternal deaths in the sense that they occurred "during pregnancy or within four weeks after the termination of pregnancy or later if illness originated during pregnancy, child birth or puerperium". Of this series of 300 deaths, 241 were deaths directly due to child bearing, 50 were due to an independent disease concurrent with pregnancy or child birth, and 9 were due to causes not sufficiently known. Of the 241 deaths directly due to child-bearing, 32.7 per cent. are accounted for by sepsis, 25.3 per cent by haemorrhages, and 5.4 by shock and accident of labour.

Important researches in nutrition were carried out during the year at the Pasteur Institute of Southern India, Coonoor, and at the All-India Institute of Hygiene and Public Health, Calcutta. Attention was focussed at Coonoor on the study of two problems: the nutritive value of Indian foodstuffs and the diet and "state of nutrition" of the population.

A systematic survey of Indian foodstuffs was undertaken, the first stage of this investigation has been completed, some 200 common foodstuffs having been investigated for energy value and content of proximate principles of calcium, phosphorous and iron. The majority of these foods had not previously been analysed in India. Simultaneously, the vitamin A and carotene content of some 170 common foods has been determined by the spectrographic method. Investigations have been carried out on the effect of storage and other factors on carotene and vitamin C content, and the interesting observation made that in certain vegetable foods an increase of carotene may take place after harvesting. The vitamin B_2 content of food stuffs is being studied by biological assay. This investigation is of considerable interest since it has been discovered that one of the common food deficiency diseases in South India—stomatitis is caused by lack of one or more of the factors present in the vitamin B_2 complex. Data obtained in a survey of foodstuffs have already been used for the investigation and planning of diets; in fact, much of the field work carried out during the year would have been impossible without such information. The effect on nutritive value of Indian cooking methods is also being studied, and attention is being given to the

availability of minerals, for instance, iron and calcium in various foods. Though much work yet remains to be done, sufficient material has been accumulated for practical application, and all available information about the nutritive value of Indian foods, together with accounts in simple language, of principles of nutrition, instructions how to devise "cheap balanced diets," etc., are being passed on to the public in "Health Bulletins."

In an enquiry undertaken at the All-India Institute of Hygiene and Public Health, an attempt is being made to elucidate the epidemiology, pathology and bacteriology of tuberculosis in India; in addition, attention is being given to some cognate problems like the part played by solar radiation in influencing tuberculous infection in the tropics, some non-tuberculous diseases which stimulate tuberculosis, etc. It has been found that although tuberculosis is not a disease peculiar to the tropics, the complexion of the infection and the disease is considerably different from that in other countries. It has now been proved, as a result of these investigations, that the hypersensitivity of the Indian population to endemic infection is more marked than in the highly industrialized and urbanized European population. A study is also being made of the spread of tuberculosis infection, morbidity and mortality in infected households, especially among children below 15 years.

The study of some of the inorganic preparations of indigenous medicines was continued, and investigations on *Banga Bhasma* (calcined tin) and *Lauha Bhasma* (calcined iron) were completed and results published. Crude oxides of tin have been used in the old Hindu medicine in the treatment of skin diseases, and in view of the fact that there is a tendency for this metal to accumulate in the system, these observations are rather interesting. It has been observed that workers in tin mines did not suffer from furuncles, and based on this observation, stannoxyl was introduced in the treatment of furunculosis.

A study of *Lauha Bhasma*, says the report, shows that ancient Hindus appear to have possessed a more advanced knowledge of the uses of iron, and appreciated that iron preparations should be administered in an assimilable form. *Swarna Bhasma* is now being studied.

Drug Addiction Theory

There were also interesting investigations on drug addiction. Studies on the effects produced by hemp drugs in all its common forms, *ganja*, *charas*, and *bhang*, were carried out both in man and laboratory animals. There were also studies on the water content in the blood of opium addicts, both before and after withdrawal, as well as during the course of treatment. As a result of these investigations, new lines of treatment have been suggested which are now being tried.

There were also, during the year, studies on the action of snake venoms and some interesting results have been obtained in connection with their haemolytic properties.

The principal object of anti malarial drugs enquiry, for which the Director, Malaria Survey of India, was himself responsible, was to popularize the use of cinchona alkaloids and to find out what effects short courses of the treatment given to all cases of fever have on the prevalence of the disease under rural conditions. This enquiry was carried out in a village near Karnal during the previous malaria season and included house to house visits to detect cases of fever, treatment of fever cases by cinchona febrifuge, weekly blood and spleen examination by accurate scientific methods, and experiments on monkeys to test the anti-malarial value of certain drugs.

Geodetic Survey of India—Report for 1936

Primarily concerned with the investigation of the size, shape and structure of earth, geodetic work of the Survey of India consists of triangulation, latitude, longitude and gravity determinations. From these, the exact "figure" of the earth is obtained where points fixed by triangulation can be accurately located on its curved surface. This system of fixed points holds together all topographical and revenue surveys, and the existence of such a system from the early days of the Department has enabled it to avoid the embarrassments caused in other countries where isolated topographical surveys have been started without a rigid framework with the inevitable result that they could not be fitted together.

Essential in any large survey as a geodetic framework is, there is, however, a number of other

activities of an ultimately utilitarian character which can be suitably combined with it, and some of these which are being carried out in India are precise levelling for the determination of heights; tidal predictions and publication of tide tables for 41 Ports between Suez and Singapore; magnetic survey, observation of direction and force of gravity, astronomical observations to determine latitude, longitude and time, and seismographic and meteorological observations.

It is some of these manifold activities of the Geodetic Parties that take them far afield into unchartered regions.

In the year under report, primary triangulation to determine latitude, longitude and the stages of the main survey framework was carried out in the Naga Hills on the Assam-Burma frontier.

The programme involved observations at a chain of stations running through the unadministered Naga Hills of Assam and Burma for over a hundred miles as far as the Chindwin river, and thence southwards into administered parts of the Myitkyina and Upper Chindwin districts.

Here is a story about this work which might well have been taken from a book of adventure.

Much of the country traversed had never before been visited by an expedition. The people were known to be very war-like and most of the villages were stockaded, and men travelled about in fully armed parties. In one area an armistice was specially arranged between two villages while a Survey Party was in the vicinity. As the probable attitude of the people towards the Party was unknown, an armed escort was considered necessary, and in addition a Political Officer was attached to the Party. On the whole, however, the people proved friendly though inter-village warfare was only too evident and head-hunting the common practice. No local supplies could be counted on, and coolies were the only form of transport on the steep forest-clad hills. The two main problems, therefore, were supplies and transport, complicated by the language difficulty. It would be hard to say how many entirely different languages were met with. Certainly a new one for each hill station would be no exaggeration and a chain of two interpreters was often necessary. The supply question was solved by forming dumps at suitable central positions, and two such dumps were formed in Assam by coolie convoys, the first at the Tirap outpost and the second on the Patkai watershed, a third dump was collected at Dalu on the Chindwin, but owing to difficulties of water transport because of the rapid stores had to be brought here overland from the Burma Railway at Mogaung, a distance of 140 miles and 100 Chinese mules were engaged for the purpose. As regards transport, a great deal depended on what local coolies could be collected in the unadministered areas and very little information on this point was available. For this reason 200 Sema Nagas were enlisted at the outset to form a permanent nucleus of reliable carriers. Lastly the language difficulty was overcome satisfactorily by the Political Officer who picked up local men of influence as he went along.

Perimeter camps were built when the party was in the unadministered territory. The perimeter consisted of a fence round the camp protected by a hedge of pointed bamboo spikes. Permanent guard duties were carried out by the escort of Assam Rifles. Outside the perimeter sufficient ground was cleared to prevent anybody approaching without being seen. No local men were allowed inside the camps except under guard, and never more than 10 coolies at a time even when loading or unloading baggage. The permanent coolies were given white bands to distinguish them at night.

Information from Burma was very meagre, and it was only shortly before crossing the border that it became known how sparsely populated the country was between the Patkai and the Chindwin on the proposed line of advance southwards.

The Patkai seems to attract clouds almost all the year round and snow and wind completed a singularly bleak situation. The temperature at times seldom rose above freezing point in the middle of the day and a minimum temperature of 23°F was recorded. But the permanent Naga coolies living in bamboo shelters with little clothing and only a single blanket came through this very trying time without a single complaint.

At one place a serious accident was narrowly averted. The station is situated on a steep promontory with cliffs on three sides, and a detachment arrived at the hill on a stormy night in the dark. The

coolies were carrying torches and sparks from these set fire to bushes near the station. Fanned by the gale the fire grew violent and could not be put out, and in the end it was all ablaze.

On the 10th March the whole party started for home. A group with a majority of the escort and permanent coolies marched overland to Singkaling Khamti, while another went down the river with 12 boat rafts carrying the sick and much of the heavy baggage. The river party had a strenuous time getting down the rapids. Two rafts capsized at one rapid with the loss of some provisions and other small articles, and at another rafts had all to be unloaded and dismantled before pulled down the fall.

Gravity Observations

Purely scientific aspect of geodesy is observations of the intensity of gravity. These observations were made at 36 stations in North Western India. In places slight increases in the strength of the earth's pull revealed the presence of abnormally dense areas in the earth's crust, while in other places deficiency of density is revealed.

Another means of securing knowledge of these peculiarities of the earth's structure lies in the study of surface known to scientists as the Geoid, whose undulations correspond to underlying excess and defects of mass. In this branch of Geodesy India is setting an example which other countries have to follow. In the year under report, the cross section of the geoid was measured along lines from Bombay to Vizagapatam and from Mangalore to Madras.

In a general review of gravity work, the report has some interesting observations to make on the causation of earthquakes.

A frequent explanation of earthquakes, it says, is that they are part of the process of isostatic adjustment. Thus the denudation of mountains and the consequent deposit of alluvium on the plains is said to lead to an increasing lack of equilibrium, resulting finally in an earthquake which tends to restore it. This, however, is precisely what is not happening in Northern India. The Gangetic Plain is an area which is greatly underloaded while the outer ranges flanking it are overloaded, so that the whole effect of the extensive denudation of the mountains which is going on is to restore equilibrium both in the mountain area and the plains. Earthquakes in this area therefore cannot be ascribed to any superficial cause. Seismographic records inditate a small focus at a considerable length. Some earthquakes originate at a great depth, 100 miles or more down. These are exceptional, but the normal depth of focus is between 10 and 30 miles, that is well below the granit layer, and either within or below the intermediate layer. The normal earthquake therefore appears to indicate movement in or below the intermediate layer and is in fact part of the process of crustal warping. The thrusting, folding and fracturing of surface rocks is only a secondary effect dependent on local geological conditions. The stability of peninsular India is perhaps due to the fact that it has been crossed by some systems of warping cuttings at more or less right angles to each other. These very ancient warpings, long since completely stabilized, have made a sort of crossbraced structure of the crustal layers below the peninsula strengthening it, so that it is now capable only of very gentle undulations.

Equally interesting are the revelations made by the study of subsoil water levels.

The vast alluvial deposits of the Indo-Gangetic Plain, it is said, hide an underlying rocky floor. A very detailed survey covering an area of about 3,000 square miles has been made and the end of a long ridge, buried below the silt, which extends to near Delhi has been charted in detail. To this ridge has been given the name Shahpur Delhi ridge. This ridge lies directly across the otherwise normal direction of flow of subsoil water, and appears to be continuous with no gap through which water can pass. The subsoil water therefore must have filled up the basis north of the ridge until it could flow over the top of it. Water in silt behaves like a very viscous liquid, and viscosity causes the subsoil water to head up an obstacle. Whether the heading up is so great as to cause water logging depends on the depth of the ridge below ground level, on the restriction of flow, and on the amount of water flowing. While there is evidence that there has been an increase in heading up in recent years, water level sections show plainly that there was already a heading upstream on the Shahpur-Delhi ridge a quarter of a century ago.

In the Doabs the water level south of the ridge is still very high; it falls rapidly to the east of the Doabs. North of the ridge there is no corresponding change on leaving the Doabs. The high water level in the Doabs is at least partly due to seepage from rivers and canals, but there is also some evidence both from gravity and geological data of a spur running south-west from the ridge under this area. Whatever the cause, the effect of the ridge in the Doab sections is partly masked and far less apparent, than it is in the sections further east.

East of the Doabs lies a deep basin bounded by the Shahpur-Delhi ridge on the north, the Aravalli ridge on the east, the Jaisalmer formations on the south and the Karachi Sukkur-Sulaiman Mountain ridge on the west. All the water from the north falls into this basin and the only outlet for this and also for the subsoil water from the Indus basin appears to be a very narrow gap west of Jaisalmer. It seems likely that water levels south of Shahpur-Delhi ridge will rise until the gap west of Jaisalmer can take the flow off; after which of course water levels in the plains south of Jaisalmer will rise until a proper gradient to the sea is established.

Turning now to Sind, the report says, gravity data have long since shown that a ridge runs from Karachi towards Sukkur and thence to the Sulaiman mountains and Zhob. At first sight, since this ridge runs roughly parallel to the Sukkur Barrage Canal systems, it appeared that it would have no effect on the water-levels. Closer examination, however, shows that the hills to the west close the buried ridge south of Shewan. All this area west of the Karachi-Sukkur-Sulaiman ridge is thus closed. Subsoil waters due to the Nari and Bolan rivers, etc. and to the Sukkur Barrage irrigation have no outlet except by seepage back into the Indus. Presumably the Manchhar Lake is an indication of the tendency to water-logging in this area.

The importance of the observations on the irrigation projects which serve these areas can well be imagined. For a ridge holds up the sub-soil drainage and increases the risk of waterlogging which causes an incrustation of salt at the surface of the soil and is one of the greatest anxieties of the irrigation engineers.

Police Radio

The Boston Police Department of U. S. A. has recently established the first practical ultra-high-frequency two-way duplex wired broadcast radio system for mobile units, *e.g.*, police radio cruising cars and boats. There is a central transmitter operating on 35·6 mc. and at an average power of 1 kW. obtained from two water-cooled valves. The microphone is placed in the room of the "dispatcher" from where he controls the transmitter by a remote-control system. The dispatcher with the help of telephone operators in his room is always available to the public for any emergency.

The department has equipped 77 two way radio cruising cars; there are also police boats equipped with two way radio. The car receivers are absolutely noiseless when no transmission is being sent out from the headquarters. Each car and boat is also equipped with a transmitter working on a frequency of 30·1 mc. at a power of only 10 watts. Suitable filters allow one and the same antenna to be used both for transmission and reception by the cars.

The message from the cars are not received directly at the headquarters but by eight pick-up stations distributed throughout the city. The radio output of these stations is carried by land lines to the dispatcher's desk where shadowgraphs at once indicate which of the pick up stations is receiving the car signal the best. The dispatcher now establishes communication with the car through this pick up point. In cases of extreme emergency when, for example, a crime has been committed, the message is sent on the air directly by the headquarter transmitter so that all radio cars receive this message simultaneously.

International Congress of Esthetics

It has been announced in *Revue Philosophique*, March-April '37, that the Second International Congress of Esthetics and the Science of Art will be held in Paris on 8th August 1937. There will be altogether four sections in it which are as follows:

(*i*) General Esthetics and history of Esthetics.

(*ii*) History and Criticism of Art.

(*iii*) Science and technique of Art.

(*iv*) Esthetical Psychology.

NOTES AND NEWS

A general discussion will be held in the plenary meeting of the Congress on the following topics:

(*i*) Esthetic and Science of Art.

(ii) Some recent methods in Esthetics: (phenomenological and psychoanalytical)

(*iii*) Esthetics, Sociology and Culture.

(*iv*) Important trends in modern European Art.

All communications and subscriptions (60 frs for full membership and 40 frs for associate membership) should be sent to the Secretary, 27, Boulevard Saint Michel, Paris.

International Petroleum Congress

It is reported that the International Petroleum Congress was held in Paris on the 14th of June 1937 under the presidentship of Mr Charles Bihoreau, Director, Office Nationale des Combustibles liquides. There were altogether five sections in it, each dealing with some special problem of petroleum technology. The sections were as follows:

1. Geology and boring problem;
2. Physical Chemistry and the refining of petrol;
3. Material and Construction;
4. Technique and utilization of the by products of petrol;
5. Economy and statistics.

Several excursions to different petroliferous regions of France and Morocco were organized by the Committee. It may be recalled that the last Congress was held in London in the year 1933 under the presidentship of Mr T. Dewhurst.

Monument at Hathgaon in the United Provinces

To the large number of monuments in the United Provinces maintained by the Government of India, a recent addition has been proposed. This is the building known as Hathikhana or Jai Chandi in village Hathgaon, tahsil Khaga, Fatehpur district. The village of Hathgaon like other places which have claims to great antiquity is situated at considerable height above the surrounding plain. Among the interesting ruins the most prominent are those of a Fort known, owing to its wide expanse, as Hathikhana or stable for elephants. Another name given to it is Jai Chandi, apparently from Jai Chand, the last Hindu Ruler of Kanauj, who lived at the end of the 12th century A.D. The association of Jai Chand with the place, however, appears to be adventitious, as its historical antiquity dates to long before his time. But the name of the last Hindu King was probably a convenient one to give when the Hindu rule had disappeared, and its present survival only points to the Hindu origin of the place. The only building worth preserving at Hathgaon is a dilapidated mosque which must have been constructed shortly after Muslim occupation, the materials being provided by the ruins of the older faith. There are 24 pillars here, arranged in rows of six, with some of the ancient doorways, sculptures, and architectural fragments built into the structure. At least 4 Hindu temples seem to have gone into the construction of the mosque which is generally attributed to the rule of the Sultans of Jaunpur in the 15th Century A.D. After the building had been consecrated to Islamic worship, it again seems to have fallen into neglect, and it was only recently that the local public got interested in it. The custodians of the place have, however, no objection to the repairs of the building being undertaken by Government as they feel that it will not be possible for them to maintain this ancient structure in a way commensurate with its antiquarian value.

New Fellows of the Royal Society

At the meeting of the Royal Society held on May 6, the following fellows were elected:

Dr J. D. Bernal, lecturer in crystallography, University of Cambridge; Prof A. C. Chibnall, assistant professor of biochemistry, Imperial College of Science and Technology, London; Prof G. R. Clemo, professor of Chemistry, Armstrong College, University of Durham; Dr A. N. Drury, lecturer in pathology, University of Cambridge; Prof H. Munro Fox, professor of zoology, University of Birmingham; Prof W. E. Garner, professor of physical chemistry, University of Bristol; Dr S. Goldstein, lecturer in mathematics, University of Cambridge; Dr Percival Hartley, National Institute for Medical Research; Prof H. L. Hawkins, professor of geology, University of Reading; The Rev. J. E. Holloway, lecturer in botany, University

of Otago; Dr W. Hume-Rothery, Warren research fellow of the Royal Society; Dr T. G. Mason, Cotton Research Station, Trinidad; J. Reid Moir, archaeologist; Dr M. L. E. Oliphant, Cavendish Laboratory, Cambridge; Dr C. F. A. Pantin, lecturer in zoology, University of Cambridge; Dr D. R. Pye, dy. director of scientific research, Air Ministry; Dr E. C. Stoner, reader in physics, University of Leeds.

New Short-wave Transmitters for India

In SCIENCE AND CULTURE, February, 1937, we referred to the new short-wave transmitters which have been proposed to be erected at Delhi, Calcutta, Bombay and Madras. We understand that the transmitters which are being constructed by Philips, are improved models of K.V.F.H. 10/12 already in operation at Tandjong-Priok. The following technical details which appeared in *Philips Transmitting News 14*, No. 1 may be of interest to our readers.

The trannsitter type K.V.F.H. 10/12 has an output of 10 kW for the unmodulated carrier; the various H.F. stages, up to the frequency doubling stage and the output stage itself are designed for a frequency-range of 3332 to 10,000 kc/sec. (Waverange from 30 to 90 m).

The transmitter contains six H.F. stages, *e.g.*, a drive-stage, an H. F. amplifier stage, a separator stage, a second H. F. amplifier-stage and a power-stage; further three L.F. stages for the modulation-system are provided.

The drive-stage contains a quartz-driven E 415 tube; two groups of oscillator quartzes and two thermostats permit of changing over from one wave-length on the other by a simple switch manipulation. Every thermostat contains three quartzes, *e.g.*, one for the normal carrier frequency and two others for frequencies of a few kc/sec above or below the normal carrier-frequency. Should another transmission give any disturbance, it will be easy to change over to a frequency differing a little from the normal frequency and to avoid interference in this way.

The first H. F. amplifier-stage contains one tube QC 05/15, the separator stage two screen grid tubes QB 2/75, the second H. F. amplifier stage two tubes of the same type, the frequency-doubling stage two tubes TA 10/5000 K and the output stage two tubes TA 12/20,000 K; moreover two spare tubes TA 10/5000 K and TA 12/20,000 K have been provided for.

Modulation occurs in the last H. F. stage; the modulation system consists of three L. F. stages, which contain respectively one tube MC 1/60, two tubes MA 4/500 and two tubes MA 12/15000 besides two spare tubes of this type.

With the exception of the smallest rectifier, all the rectifier tubes are gasfilled low vacuum rectifiers of the type DCG 4/1000, DCG 2/2000, DCG 5/2500 and DCG 10/15.

Output of Electricity in Great Britain

The official Returns rendered to the Electricity Commissioners show that 2074 million units of electricity were generated by authorizid undertakers in Great Britain during March, as compared with the revised figure of 1753 million units in the corresponding month of 1936, representing an increase of 18.3 per cent. The number of working days was 25 as against 26 last year.

During the first three months of 1937 up to the end of March, the total amount of electricity generated by authorized undertakers was 6194 million units, an increase of 11.7 per cent. —*World Power.*

Pulitzer prize awarded to Mr G. B. Lal

Mr G. B. Lal, the science editor of *New York Times*, has been owarded the Pulitzer Prize along with four other journalists for his meritorious reporting of the work of the Tercentenary Celebration of the Harvard University.

Science in Industries

Neoprene—A new synthetic Rubber

Rubber is such an important material for all civilized nations both in war and peace that for a long time scientists have been busy attempting to find out a chemical rubber which would be able to replace natural rubber for all practical purposes. Though an exact substitute of natural rubber has not yet been obtained, scientists' investigations have yielded a variety of synthetic products highly satisfactory for certain purposes. The latest in this line is Neoprene—articles made of which were recently shown in an exhibition opened by the Imperial Chemical Industries, Ltd., in London.

From a note in the *Electrician* (April 30, 1937) describing this product, we learn that Neoprene has rubber-like properties and can be used for purposes for which natural rubber is wholly or partially unsuitable, but it is not a substitute for natural rubber. The material is really polymerized chloroprene. The presence of chlorine was viewed with suspicion at first but subsequently it was found that chlorine improved the final quality and also cheapened the product. Products of the old synthetic process, based on Isoprene, had the disadvantage that they were difficult to mill. This was because their molecules were in the form of branched chains. By introducing chlorine the molecules have been made to form long, straight chains as in natural rubber. Neoprene is the first "synthetic rubber" with this molecular construction, and the material possesses all the elasticity and tensile strength of the best natural rubber, to which it is incomparably superior in its resistance to oils and certain solvents. It has also a higher resistance to ozone and ultra-violet radiation, is less affected by chemicals and less permeable to gases. Oil resistance of Neoprene makes it suitable for manufacturing washers and packing in all industries. Another obvious use is for transmission and conveyor belting working under oily conditions. The resistance of the material to ozone, the well-known "Corona effect", heat, and flame makes it suitable for use in high tension cables, lead-in cables for neon signs, and even for light flexibles.

Future of Indium

In 1863, while searching spectroscopically for thallium, F. Reich and T. Richter found the presence of a strong line in the ultra-violet part of the spectrum which was later found to be characteristic of a new element. This element received the name indium. Richter succeeded in isolating the element and in determining some of its properties and in 1867, he presented a few pieces of metals to the Academy of Sciences. Indium is a soft metal crystallizing like aluminium melting at 76° and with a specific gravity of 7.2 and atomic weight 114.8.

Some of the salts have been prepared and studied but on account of its rarity and difficulty of extraction it has not received much attention from the chemists. Will indium remain a scentific curiosity like many other substances till some industrial use is found or should it be developed and its production intensified? It is not possible to say much on this at present. In the United States of America, a company has been started with the name of the Indium Corporation of America which has extracted a few pounds of the metal out of some minerals in Arizona. The price has also been lowered proportionately. Indium was practically unavailable commercially up to 1924. In 1930 the price was 10 dollars per gram but in 1936 it has come down to 1 dollar per gram, which is a little less than the price of gold.

The important properties of the metal which have aroused the interests of the industrialists are the following: It is softer than lead, more brilliant than silver, as unalterable as gold. It is probable that indium will be largely used in jewellery. Alloyed with other metals like silver, copper, gold, tin, cadmium and palladium it gives a resistant metal which does not tarnish when exposed to air and it can take a beautiful polish. Another important porperty is its very low melting point. It is well known that

when two metals are correctly alloyed, the alloy melts at a lower temperature than either of the constituent metals. For example, by preparing suitable alloys of bismuth, lead, tin and cadmium it is possible to bring down the melting point to about 100°. Darcets' alloy is a well-known classical example. If indium is mixed with such an alloy the melting point can be brought down to as low as 45 °—a little over body temperature. The liquid metal can be put in direct contact with the skin without any harm being done. This alloy can be utilized for making models more rapidly than plaster, for taking the mould of things and for making more resisting replicas. As it is malleable at ordinary temperature it can be used in surgery for treating fractures. Various other uses are possible of indium and its alloy and its industrial applications will increase as its price comes down.

—La Nature

World Production of Automobiles

The production of motor car in 1936 rose from 5,125,000 to 5,850,000 which is an increase by about 14 per cent. In this world production the shares of the principal producing countries are as follows:

U. S. A.	..	74.5 per cent
Great Britain	..	7.9 ,, ,,
Germany	..	7.1 ,, ,,
France	..	3.5 ,, ,,
Canada	..	2.6 ,, ,,

The number cars constructed in the U. S. A. went up to 3,630,000, and lorries to 775,000, but in spite of this the share of America in the world production diminished and the America production of cars is still considerably below the record figure of 1929. In England the production reached a figure double of that for 1929. In Germany, the number of new touring cars manufactured was 240,300 against 205,500 in 1935. In France also, in spite of various difficulties, a considerable recovery was recorded with a production of 210,166 cars against 177,362 in 1935.

Among the producing countries only Canada shows a decrease while in U. S. S. R., in spite of the lack of official statistics, it appears that the production of automobiles did not reach the figure of 160,000 according to the plan. However, it is estimated that the factories at Moscow and Gorki produced more than 100,000 cars last year.

La Nature.

World Production of Petrol in 1936

During 1936 the world production of petrol was 245 million tons against 227.1 million tons in 1935. The share of U. S. A. in the world production again increased from 136.2 to 149 million tons. 60.82% of the total amount in 1936 came from American wells while in 1935 it was 59.95%. The other petroleum-producing countries in order of their importance are:

U. S. S. R.—27 million tons against 25.2 m. tons in 1935: (11.02%).

Venezuela—22.7 m. tons against 22 m. tons in 1935: (9.26%).

Roumania—8.7 m. tons against 8.4 m. tons in 1935: (3.55%).

—Sciences et Voyages.

U. P. Ganges Hydro-Electric Scheme

During 1936 and the first two months of 1937, four of the canal power stations on the Ganges hydro-electric grid system in the United Provinces came into operation. The scheme envisages altogether seven of such stations with a combined capacity of 18,900 kW and a steam station of 9000 kW.

Whilst, from an electrical point of view, the size of the scheme may appear small, its importance, both as regards power supply and irrigation, for the economic welfare of the area is very great. Power supply rates to rural and cottage industries will be as low as anywhere in the world. During 1936, 488 State wells were supplied with power for pumping, and the total area now irrigated is 118,677 acres.

—World Power

Utilization of Bagasse

Bagasse or the sugar cane refuse is one of the most important by-products of sugar industry which now occupies such an important place in the economic life of our country. Bagasse is considered a waste product in India and about three million tons of this material is burnt annually as fuel for boilers. In the following article Dr R. N. Ghosh shows how bagasse can be very profitably utilized for the manufacture of fibre boards, a very useful material with a veriety of uses.

The Utilization of Bagasse

R. N. Ghosh

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With the increase of tariff and duty and the total outturn of sugar by the factories, competition in the sugar market has become exceedingly keen. The Indian production is probably more than the country can consume. As a consequence, the sugar industry will have to face a big crisis sooner or later. The manufacturer, who foresees this and makes attempts to overcome it, will in the long run survive. The present note is chiefly meant to draw the attention of the manufacturer to the utilization of the waste products, *viz.*, bagasse, the sugar cane refuse. In all manufacturing business the complete utilization of the waste products is a most important factor. In India, at present, the sugar mills have been content with manufacturing sugar from cane and using the bagasse as fuel for the boilers. Since bagasse has a low value, constant attempts were made in other countries to find a more profitable use for it. Cane fibres cannot be used as fodder, nor can they be used as manure, since the fibre resists decay, but they are quite suitable for making fibre boards. After prolonged research Celotex Company in America evolved a process by which the fibres were compressed into boards known by the trade name Celotex. These boards have found various uses on the market.

The utilization of bagasse has, in fact, saved the sugar industry in Louisiana from extinction and has affected the sugar market of the whole world. The scale of Celotex is recorded as follows:—

Year	Celotex Sq. Ft.
1928	260,650,000
1929	333,225,000
1930	460,000,000

Thus, it will be observed that the sale of fibre boards has been steadily increasing. In 1927 Mr E. A. Vazques, a well-known sugar and paper mill engineer, patented in Cuba a process which is known as the Vazacane process by which it was possible to join in operation a method for extracting all the juice from the cane and a preparation of the fibres so that they can be directly formed into board, all by a simple mechanical process. Boards manufactured by Vazacane process have slightly different physical characteristics from Celotex, but the uses are practically the same.

The production of bagasse in various countries is tabulated below:

Country	Tons of bagasse.
Louisiana and Florida	250,000
Cuba	5,156,000
India	2,735,000
Java	2,939,000
Phillippines ..	637,000
Australia ..	532,000
Formosa and Japan ..	815,000
Brazil	675,000

From the above table it is clear that India holds the third position with regard to the production of bagasse, but unfortunately all of these 2,735,000 tons of bagasse are nearly wasted. Imagine one ton of bagasse yielding 2,240, sq. ft. of fibre board priced at Rs 3,360 in India. The cost of manufacture is not known, but one can leave a large margin as the cost of manufacture and an equivalent price for one ton of coal! The cost of manufacture will vary with the process of manufacture. In the vazacane process it is certainly less than in others. These details are left out for the business men to discuss.

The possibilities of fibre board trade in India and elsewhere are increasing every day. Let us first consider the use of cheap fibre boards. With the development of small industries and business, the circulation of catalogues has increased and these are given a soft board cover. It is certainly cheaper to use fibre boards manufactured from bagasse than to use soft boards made from wood or grass pulp. Cheap books are fitted with soft fibre boards. It has not been possible to find the exact quantity of fibre boards that imported in India, but it cannot

be doubted that soft fibre boards will find a ready market. Similarly no exact data are available regarding the boards which are imported for heat and sound insulation. At present whatever quantity is used in India is all imported. These boards are compact but porous and possess a high sound and heat insulation properties; they are generally used in council chambers, auditoriums, public offices etc., in order to improve the audibility and minimize noise, the effect of which is to lower the efficiency. Many takie houses are now fitted with sound absorbing boards, such as Celotex, Treetex. The Council Chamber of Delhi is fitted with acoustic tile which has to be fitted during construction and the Lucknow Council Chamber has now been decorated with a spray of sound absorbing paste.

Fibre boards are also used, as said before, for heat insulation. With the advance of civilization and business the demand for a cool house during summer is increasing. Walls lined with heat insulating materials will prevent heat from entering and when the room is once cooled the temperature can be kept comfortably low. The demand for heat insulation material has greatly increased with the development of refrigeration industry. The preservation of food-stuff and fruits by cold refrigeration has been put on a commercial basis: and in other countries fruits are preserved for months by cold gas storage, and transported in refrigeration van. In all these cases the most important problem is to find out a suitable heat insulating material so that heat might be prevented from entering the refrigeration chamber. It will be observed, therefore, that we have a ready market for fibre boards provided that they are suitable for the above purposes.

Suggestions

Vazacane process will be too costly for small factories. What should really be done is to erect a central Board Plant maintained by all the sugar factories. To this central place every factory should send its quota of bales of bagasse. This is a mere suggestion, the Sugar Mills Association can discuss the matter and come to the best decision. The most important problem is to evolve a suitable method for the production of fibre boards from bagasse with due regards to the raw material, the climate, temperature and above all the Indian requirements. Accepting for the present the above proposition, still much spade work has to be done before we can place our goods on the market. In fact, every step one moves, the matter has to be carefully worked out after a good deal of research. For instance, if every sugar mill has to store and bale its bagasse for transportation, then care has to be taken in storing the bagasse so that it may not become unfit for use later on; *i.e.*, storing and baling also require special care.

As said before, the boards have to satisfy certain conditions before they can be placed on the market. In order that the boards may not be susceptible to the attacks of vermin, white ants, etc., the fibres have to be treated chemically before they are compressed into boards. When the board is ready, one has to find out whether it becomes crisp during summer, or swells out during rainy season. If so, the fibres have to be specially treated with chemicals to avoid these effects. In order that these boards may be used in public building for heat or sound insulation, they must possess high heat and sound insulation properties along with fire and water proof properties. In order that the board manufactured from the Indian bagasse be free from any kind of defect, a complete investigation by a combined effort of a chemist and a physicist will have to be made before any scheme is launched into practice. The whole work has to be experimented on a laboratory scale, and the work divided mainly into four classes:--

(i) Machine work to beat the bagasse into fibres; (ii) chemical process *i.e.*, to remove any remnant surcose from the fibres and six other fibrous substances for improving the fire and water proof properties, and to make the fibres insect proof; (iii) compression of fibres into boards and cutting the boards in tile shapes; and (iv) testing of the physical properties of the board. After the laboratory stage is successfully worked out the process may be put on a big commercial scale at some suitable place near a railway station.

Research Notes

Effect of Overfeeding on the Protein Metabolism of Man

Cuthbertson, McCurtcheon and Munro (*Biochem. J.*, *31*, 681, 1937) have carried out an extensive series of investigation in order to study the effect of overfeeding on the protein metabolism of man. In the first series of experiments they have determined the effect of superimposing raw and boiled milk on a diet adequate for maintenance.

The subjects selected for these experiments were students and members of the teaching staff performing routine laboratory duties. They were all of good physique—age ranging from 19 to 35 years. They were placed on self-selected constant basal diet comprised of breads, 100 gms of butter, cheese, 500 c. c. raw milk, apple jelly, and raw apples. During the experimental period they took no special exercise apart from short walks of a relatively uniform character. Twentyfour-hour specimens of urine and faeces were collected and analysed.

For 3-5 weeks the individuals seemed to be in N equilibrium as their weights tended to remain constant during this period. Having established equilibrium the subjects were made to injest extra 1 lit. of milk daily for one single day. It was found that the mean percentage retention of the extra milk N was 51 that of S 53. To test if the capacity of the organism to milk N was equal to or greater than its capacity to store the N of an equivalent amount of sodium caseinogenate, one subject was fed with a litre of sodium caseinogenate solution instead of the litre of milk. Only 33% of the caseinogenate nitrogen was retained as compared with double the amount of nitrogen retained in the case of raw and boiled milk. It appeared as if the non-protein moity of the milk contributed to the nitrogen.

Next question was to determine whether this extraordinary retention would still occur when the period of milk injestion was prolonged. For this purpose an eight-day superimposition experiment was conducted similar in nature to the one-day experiment detailed above. It was found that very definite retention of milk nitrogen occurred during these experiments and that the retained N appeared to remain stored within the organism on return to basal diet. It was also found that in this respect no real difference existed between the nutritive values of the protein of raw and boiled milk. These extraordinary N retentions were coupled with increase in body weight.

After this experiment with milk they proceeded to determine the effect of superimposition of beef (or soya flour), lactose and butter, equivalent in protein, carbohydrate and fat content to a litre of milk on a diet adequate for maintenance. The retention of N in this experiment was 21.7% over the period of 15 days when lean topside beef was used. But when soyabean was substituted for beef the percentage of N retention after 5 days' superimposition was 34.

H. N. B.

A New Ultra-High-Frequency Valve

Recent developments in television transmission have necessitated the manufacture of valves giving adequate power output at ultra-high frequencies. With ordinary power oscillators the efficiency and hence the power output decreases as the frequency is increased on account of the lead inductances and inter-electrode capacities. The tendency, in recent years, has been to construct special types of high-power valves giving large outputs at frequencies of the order of 100 mc. as are used in television work.

Messrs Eitel-McCullough, Inc., California, has manufactured such a valve known as the 1000 U H F. A description of the novel features in its design

might be of interest. It is a radiation-cooled valve having an overall height of 13 inches and a bulb diameter of 5 inches. The plate dissipation is rated at 1000 watts, provided the bulb is cooled by a blower. The filament is of thoriated tungsten and consumes 16 amperes at 7·5 volts. The average plate current is 700 m.A. and grid current 100 m.A. and the output at 100 mc. is of the order of 1 Kw.

The anode of this valve is made of tantalum and is provided with 18 cooling fins instead of being purely cylindrical so as to increase the heat radiating surface. The grid is also of tantalum and is of the vertical bar type in order to reduce grid inductance. The valve is characterized by somewhat unusual grid mounting, and plate and grid leads in order to diminish the grid-filament capacity and r.f. resistance respectively. The grid, instead of being mounted according to the conventional clamp type, is mounted as one unit with the filament, sufficient insulation being provided by a special type of stem.

There are three sealed-in tungsten leads extending through the glass for each of the anode and grid. The leads for each of the electrodes are welded to solid copper bars which in turn are terminated in a solid copper button. In order to minimize the possibilities of puncture of the glass due to corona effects the button does not contact the glass. The button is drilled through so as to insert a small glass tube through which air under pressure may be directed on the seals to keep them cool.

Sex Differences in Human Skull

Borovansky has studied 132 male and 115 female skulls in the Anatomical Institute of the Charles University of Prague and has found the sex difference from the above data. Following is a summary of his conclusions.

The characteristic points of dissimilarities are found in the development of the region of glabella. Supraorbital ridges are found in pronounced condition in male skulls but never in female skulls. Vertical forehead bends abruptly into the cranial vault. This is found only in females to the extent of 20%. The external occipital protuberance is noticed more markedly in males than in females. The mastoid process is generally bigger in male. According to the data of Borovansky, the proportion of large mastoid process is 35·6% in males and 12·3% in females. Regarding the nasal bones no difference is yet met with, but nasal spine is slightly more developed in males than in females. Of chin there are some distinct types : round chin occurs in 25% of males and in 53% of females; flattened chin in 57% of males and in 35% of females, while square chin with lateral prominences occur in 14% of males and in 5% of females. Alveolar prognathism is more pronounced in female skulls than in the males. The dimensions of the cranium are greater in the male than in the female. Sexual differences are specially noticed in the bizygomatic, bijugal and bigonial breadth and in the length of the face, *i. e.*, nasiongnathion line. Studying the skulls of both sexes it is found that female skulls tend towards brachycephaly, towards euryprosopy, towards higher nasal index, and lastly towards slightly higher orbital index. If the facial angle is considered it is found that female skulls are orthognathous. The teeth in the male are bigger than in the female.

Minendranath Basu.

Sumero-Babylonian Inscription at Mohenjo-daro and Date of the Indus Valley Civilization

In the *Indian Culture* (April, 1937) Dr C. L. Fábri announces the discovery of an earthenware pottery (Hr 909) containing a Sumerian ideographic inscription or potter's mark consisting of the signs for barley and reed. So far Indian seals have been found on several sites in Iraq, *e. g.*, Kish, Ur, and Tel Asmar which had proved that there was a lively commercial intercourse between the Indus Valley and ancient Iraq. From these finds dates for the Indus Valley Civilization have been deduced varying between 2000-2800 B. C. It was quite natural to suppose that objects with ancient Sumerian ideograms should be found on

Indian soil. If Dr Fábri's interpretation, which has the support of Dr F. M. Böhl, the famous Assyriologist of the Leyden University, be correct, this pottery jar is the first Sumerian object found on Indian soil. Dr Fábri finds that the sign is identical with the sign for barley and reed used in ancient Iraq. This particular ideogram underwent continuous change from 3000 B. C. to 2300 B. C. From the particular variety of ideogram found on the jar the date has been fixed at nearly 2600 B. C.

The interpretation of the sign is not yet clear. According to one interpretation, it means 2 qa of barley (8 litres). According to another, it simply means 200. Fábri is inclined to favour the second interpretation as many of the potteries discovered on this site have been found to be numbered.

A Stratosphere Solar Observatory

In *Bulletin* 905 of the Harvard College Observatory, there appears an article, with the above heading, by Prof. M. N. Saha, written during his stay in the Harvard College Observatory in the summer of 1936.

The title of the paper is however misleading, for, if interpreted directly, it is equivalent to "Building Castles in the Air." What Prof. Saha pleads for is that a regular programme should be organized for sending balloons to a height of thirty-five to forty kilometers, provided with quartz, fluorite and vacuum spectrographs which will be automatically exposed to the rays of the sun when the balloon is at the highest point, and will bring down records of the solar spectrum taken at this height.

A programme like this may be new to astronomers, but is not unknown in other branches of science. Many meteorological observatories (for example, Agra in this country) send out balloons to great heights, provided with automatic recorders of temperature, pressure, and humidity. In this way, the meteorologists are making a survey of the weather conditions of the upper atmosphere but there is one disadvantage. These balloons, after completing their flights burst after a prescribed time and come down to earth. Anybody bringing the remains of the balloon gets a reward. But a large part is lost. Recently, the Soviet physicist Moltchanoff has provided these balloons with automatic transmitting apparatus (radio sonde) which transmit signals recording pressure, temperature, and humidity at the different heights as the balloon ascends and descends. One has not to depend on 'luck' for getting the records.

In this article, it is explained that our knowledge of the sun is very incomplete on account of absorption by a layer of ozone at a height of 20-50 km. This cuts off the spectrum below λ 2900. Absence of all knowledge of the spectrum below λ2900 is responsible for our inability to understand the mechanism of solar radiation in the ultraviolet which causes ionization of the upper atmosphere, and produces the Ionosphere. But the ozone layer has been shown to be situated between 20 and 40 kms, and if the solar spectrum can be taken above this height, we shall have direct knowledge of the ultraviolet part of the solar spectrum, and this knowledge will be of immense advantage to meteorologists and radio physicists.

Prof. Saha's proposals are extremely practical, though costly, and it is hoped that the farseeing Harvard astronomers will be able to get some American millionaire to finance the programme.

University and Academy News

Royal Asiatic Society of Bengal

An ordinary monthly meeting of the Royal Asiatic Society of Bengal was held on the 7th June, 1937.

The following paper was read :-

1. G. F. Shaw and E. O. Shebbeare.—The Fishes of Northern Bengal.

The paper is in the form of a handbook of the fish of Northern Bengal and embodies observations made in the field by the authors over a period of fifteen years. The material was obtained from the rivers, streams and ponds in the hills and plains of the Darjeeling District and the adjoining Duars. The species collected from bazaars are also listed, but such names are enclosed in brackets. The species, previously recorded by earlier workers, but not by the authors are also recorded to complete the list. Local vernacular names, Bengali names, and Hindi names of the different species are given and wherever possible biological notes are added.

Identification tables for families, genera and species are included and to facilitate reference the serial number of the species in the 'Fauna' is given.

All the species are illustrated either in the text or in plates, so that there is a complete atlas of the species known from Northern Bengal. Most of the illustrations are original, the others are borrowed from other sources.

The following exhibits were shown and commented upon :—

1. Johan van Manen.—Two recent publications for which manuscripts from the Society's library have been utilized.

Like all other manuscript libraries the Society constantly lends out manuscripts for utilization in the production of scholarly editions or studies.

2. Johan van Manen.—A glossary and concordance to Firdausi's Shahnama.

The recent millenary of Firdausi has been celebrated not only in Persia but throughout the civilized world. The German Empire has published, as a jubilee gift, a sumptuous volume, with supplement, containing a complete glossary and word-concordance to the Shahnama. The author is Fritz Wolff. The main volume, of over 900 quarto pages, contains the glossary and word-concordance whilst the smaller supplementary volume contains a verse-concordance to the three editions by Macan, Vullers and Mohl. The work has been published by the 'Notgemeinschaft' of German Science in association, with the German Orient Society, who have kindly presented the Royal Asiatic Society of Bengal with a copy of these most valuable volumes.

Indian Chemical Society

J. M. Das-Gupta Memorial Medal

Applications are invited for the above gold medal for 1937 from research chemists of any age. The award will be made on unpublished researches and/or on independent papers published in the *Journal* of the Indian Chemical Society by the candidates during the years 1936 & 1937. Applications together with four copies of each reprint or typewritten paper should reach the Hony. Secretary not later than 30th September 1937.

Sir P. C. Ray 70th Birthday Commemoration Medal

Applications are invited from research chemists below 30 years of age for the above competition. Only independent papers, which have been published in the *Journal* of the Indian Chemical Society during 1936, will be considered.

Applications together with 3 copies of reprints of each paper are to reach the Hony. Secretary not later than 30th September 1937.

Further particulars for the above competitions may be obtained from the Hon. Secretary.

Book Review

Cosmic Rays Thus Far—*By Harvey Bruce Lemon, Professor of Physics, University of Chicago. With a foreward by Professor A. H. Compton. Published by William Heinman Ltd., London.*

"The spotlight of professional scientific attention like all other human spotlights plays about on a vast stage. It rests a moment here, a moment there. Just now cosmic rays are at its focus," writes Professor Lemon in the introduction of his new book. The author presents clearly and concisely a history of the development of various ideas regarding these penetrating radiations. The style is simple and there is no mathematics, the technicalities either being avoided or explained by taking simple analogies. The reader who knows the subject will find the book entertaining and a few hours of interesting study. The illustrations are done by Chichi Laslay, of which there is a good number in the book. It is to be noted that these typical illustrations have now become a characteristic feature of the works published for the new undergraduate curriculum of the University of Chicago. They not only explain vividly the essential points that occur in the text but taken together form a pictorial commentary of the whole theme.

The book is divided into 12 chapters, the first three of which deal with the early history when cosmic rays were explained as due to some unknown radioactive element present in the atmosphere. The first chapter also mentions different tools such as Electroscope, Geiger counter and Wilson chamber that we use in the exploration of cosmic rays.

The second chapter gives a history of the early observations. The slight conductivity of atmospheric air which persisted when all other known causes of ionization had been allowed for or eliminated was definitely established by Geital in 1900 and a year later by C. T. R. Wilson, who noted that from the time of Coulomb onwards several investigators had suspected leakage in their electroscopes to be due, in part, to the mysterious qualities of the environment. As radioactivity was discovered only five or six years ago, the cause of the leakage was at once ascribed to the traces of radioactive material either in the ordinary surrounding walls of the e'ectroscope or in the atmosphere. Geital noticed this leakage even in the depths of salt mines.

In chapter IV an account is given of Göckel's first balloon ascent in 1909 to study how the ionization in a closed vessel varied with the height. Göckel's observations were soon followed by Hess (awarded Nobel Prize in 1936 for this work on cosmic rays). He carried out measurements up to a height of 3,000 ft 'insisting that at these heights contributions from the rocks must have vanished and that any contribution from the atmosphere should have declined to a large degree with the decrease of its density; he postulated an origin for the rays outside the planet'. The origin of this was ascribed to the sun. But then we are told three pages ahead, "Curiously enough, however, he (Hess) still ascribed this penetrating radiation due to some unknown radio-active material," and a page further (p. 63) that Hess was opposed to the cosmic origin of the rays and criticized Kolhörster who definitely postulated that "the origin of the rays was not be sought along the lines of radio-activity". Even by taking the word "Cosmic" which meant only the sun at that time the sequence of ideas is rather complicated and difficult to follow, as it appears from the book that Hess was having two opposite ideas at the same time! It was soon found that there was no diurnal variation of the intensity of cosmic rays. The sun was therefore eliminated as a possible place of origin.

Not much progress was made during the period 1914-25 due to the Great War. In 1925 Millikan joined the band of cosmic-ray workers. 'His contagious enthusiasm, his fertile imagination, his ever sanguine assurance of the superior accuracy of his interpretations, together with the dogmatic style in which he phrases his writings at once filled this field of study with a host of other workers and soon resounded with the din of the battle". He found from experiments at different depths of various lakes that there are some sharp changes in the depth ionization curve, which at once revealed that the cosmic rays were not of homogeneous wavelength.

No direct spectrum of cosmic rays is possible; their absorption co-efficient is the only clue. Compton, Dirac, and Nashina have suggested different relations between the absorption co-efficients and the wavelength. These relations are empirical rather than rational in their nature and so the wavelength of cosmic rays determined from their extrapolation cannot be relied upon.

In Chaper VIII we found Bothe and Kolhörster making use of the Geiger counter to find the intensity of cosmic rays. These investigators found that the absorption co-efficient of the coincidence-producing particles was the same as the cosmic radiations and suggested that these particles might be identified with the cosmic rays. This was the first experimental fact for the corpuscular hypothesis. The particles should be charged, as only charged particles can produce ionization and therefore, should be deflected by a earth's magnetic field. It was found that the intensity depended upon the geomagnetic latitude. These investigations, though differing quantitatively, indicate that at least a part of the rays must consist of charged particles. Secondaries which might be produced would not travel sufficiently long to be deflected by the magnetic field of the earth'.

Coming from the intersteller space these particles differ in their intensity of penetration. Compton has arranged them in three groups. Group A with alpha particles, Group B with eletrons and positrons, and group C the most penetrating of all with protons. He has also suggested that the origin of these rays may be due to the outbursts of stars. If these are charged particles then they would lag behind ordinary light waves and less energetic particles will lag more. 'On such journeys various charged particles will be automatically sorted out and if detectable and if originating in Nova would themselves provide conclusive proof of the fact of their origin.'

In search of cosmic rays scientists have discovered many things of fundamental importance; in fact the discovery of positron was due to cosmic rays.

The last chapter deals with the work of Compton which shows a small periodic variation in the intensity of cosmic rays and the period is the sidereal day. This variation is explained as an effect of the rotation of the Milky Way.

A list is attached in the end in which nationalities of different scientists are given. It is interesting to note that out of a total of 88 investigators who acheived conspicuous results 31 are American, 17 are German, and 13 are English.

There is, however no mention of the longitudinal effect of cosmic rays, found by Millikan, in the book. In spite of this the author's modest claim to present a bird's eyeview of the whole subject has been more than successful.

Biroj Das Gupta.

Laboratory Method of Organic Chemistry—*By L. Gattermann (revised by H. Wieland). 1937. Pp. xvi+435. Published by Macmillan & Co. Ltd., London. Price 18 sh.*

This is one of the best books on practical organic chemistry and students of chemistry all over the world are familiar with it. The present edition, which is the 24th, incorporates many useful additions and noteworthy changes. In the analytical section, the usual macro-methods have been replaced by semi-micro-methods (or 'meso-analytical' methods, as the author calls them). The latter are modifications of the well-known Pregl's micro-methods and have been employed in the chemical labo-

ratory of the Bavarian Academy of Sciences with very satisfactory results. Improved methods are also given for the determinations of other organic radicals. A very interesting feature of this edition is the introduction of chromatographic adsorption of pigments, which has attained considerable importance of late. The theoretical principles involved in the preparation of various synthetic substances serve a very useful purpose, as it prevents the students from being too mechanical.

P. K. B.

An Introduction to Anthropology—*By Rakhal Krishna Mondal and Minendra Nath Basu, Published by the Book Company Ltd., Calcutta, 1936.*

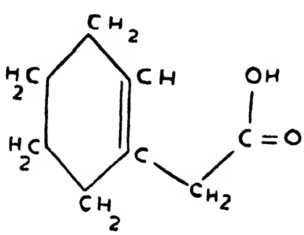
This book is meant for Intermediate students and the authors have attempted to deal within the span of a small volume subjects such as zoology (Primate group), anatomy, prehistoric archaeology, sociology, religion, etc. This has resulted in the book having the appearance of a printed edition of class notes. The book is inadequately illustrated, specially in the chapter of anatomy. The absence of illustrations of racial types in an anthropological textbook is unfortunate. The book contains a number of mistakes and misstatements many of which cannot be printer's errors and the authors have not published any errata. On page 6 it has been stated that "the study of man will enable us to guide... towards producing superior races". What do the authors mean by superior races? On pages 9 and 10 the order *Diprotodontia* has been *Dyphodontia.* On page 10 they have cited the Kangaroos as examples of Theria which would have been the best example of *Diprotodontia. Tarsius* forms a separate suborder and is not under *Lemuroidea* (p. 11). The fibula does not articulate with femur (p. 27). Weaving did not begin with mats (p. 47) but probably from basketry. In describing the early types of man the authors have omitted a large number of importent details and Boule's arguments regarding the status of *Pithecanthropus* have been ambiguously stated (p. 59). On page 84 one is shocked to read that the Nordics possess mesocephalic heads only! The authors appear to have taken the range of indices from Haddon's *The Races of Man* (Cambride, 1929, p. 26) but they have omitted the word "long" before mesocephalic. The authors' statements, "In India polygamy prevails everywhere. It is still found among the Kulin Brahmans of Bengal", are too generalized. Some of the causes of polygamy accepted by authors have yet to be proved. On page 143 the *Bregma* point of the skull is described as "the meeting point of the frontal with the parietal bones" and there are a large number of similar mistakes.

The authors have made a laudable attempt and it is hoped that they will improve the book in its next edition together with an index and bibliography. An immediate publication of detailed errata is necessary. The reviewer feels that anthropology, if it has to be taught in the Intermediate classes, can hardly be covered by a single volume. The text books should be written in parts as we have in physics.

Letters to the Editor.

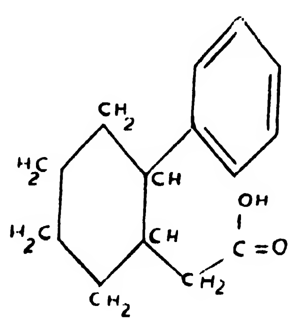
Syntheses in Hydro-Aromatic Series —A new route to Phenanthrene

Synthesis of 2-phenyl-cyclohexyl acetic acid for the synthesis of phenanthrene was published in this journal in the form of a note[1] before the paper[2] of Cook, Hewett and Lawrence came out. In fact, the latter workers, in all fairness, made mention of 2-phenyl-cyclohexyl acetic acid of the present author in their paper (*loc. cit.*).



(I)

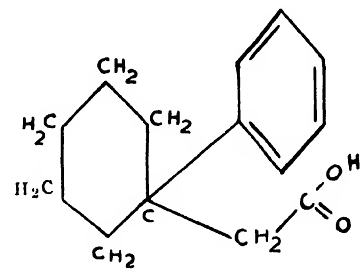
By the condensation of $\Delta^{1'}$ cyclohexen acetic acid (I) with benzene in presence of aluminium chloride, at the ordinary temperature (25-35°C), the present author obtained an acid, the constitution[3] of which may be (II) or (III)



(II)

The question of migration of the phenyl group to the position 4 of the cyclohexan nucleus, in the above condensation, as a result of which the product should have the structure of 4 phenyl cyclohexyl-1-acetic acid, has been dealt with by Prof. Cook[4] in a discussion of certain papers of the London Chemical Society. This does not seem plausible for several reasons.

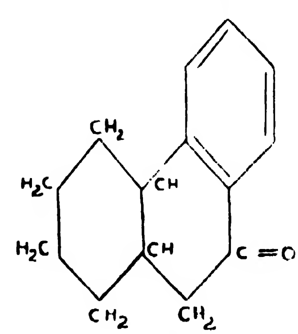
It has been found that the condensation product of $\Delta^{1'}$ cyclohexen acetic acid with benzene is identical with the condensation product of the hexa-hydro α coumaranone and benzene in presence of aluminium chloride. The identity



(III)

of the products was recorded in this journal (*loc. cit.*) by mixed m. p. of the amides of the acids of the above condensations. The boiling points of the esters and acid chlorides of the acids were also compared.

It has also been observed that the acids in the above condensations give on cyclo-dehydration in presence of conc. H_2SO_4 or 85% H_2SO_4, the same ketone m. p. 96° (Fig. IV). The oxime of the ketone melts at 176-177°. This ketone and oxime happen to be the same as obtained by Cook and others (*loc. cit.*) by ring closure of a 2-phenyl cyclohexyl acetic acid (m. p. 62-81°C) obtained by a different method.



(IV)

Hence it appears that the acid of the present author has the constitution (II) and is the same as the lower melting acid (62 84° m. p.) of Cook and others.

The doubt as to the exact constitution of the product of the above condensations was due perhaps to the difference in melting points of the acid of the present author and that of Cook, Hewett and Lawrence (*loc. cit.*). The melting point of the acid as given by the present author was 69-70° while that given for Cook's acid was 62-84°. It may be pointed out here that no mixed m.p. of the acids of the present author obtained by the two different condensations was mentioned in the paper. The mixed melting point of the acids was not observed as they did not have sharp melting points. The exact experimental conditions will be published elsewhere.

My best thanks are due to Sir P. C. Ray for his kind encouragement in this investigation.

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8.6.37.

1. Ghosh, *Science and Culture*, *1*, 229 1935,.
2. Cook, Hewett and Lawrence, *J. Chem. Soc. 71*, 1936.
3. Eizkmann, *C.*, *1*, 1416, 1904: *C.*, 1, 1388, 1905; *C.* 2, 2045, 1907.
4. *Chemistry and Industry*, *56*,, No. 12, 290, 1937.

Vitamin B_1- and B_2-content of the Jack-fruit Seeds

The ripe jack-fruit seeds are largely used in the culinary preparations of rural Bengal. The seeds have got a thin, almost transparent, stiff outer coating and beneath it there is a very thin reddish-brown sheath just like the coating of the rice grain. Owing to the large seasonal consumption of these seeds and particularly due to its close resemblance with the rice grains it was thought worth while to investigate the vitamin B-content of the jack-fruit seeds. *Method:* For the assay of vitamins B_1 and B_2 the biological method of estimation with young albino rats, as modified by Guha and Chakravorti[1] was followed.

(*a*) Five rats of each group, deficient in vitamins B_1 and B_2 respectively, were fed with 2 grams of the seeds daily for three weeks and their average weekly growths were determined.

(*b*) An acid aqueous alcoholic extract of the ripe jack-fruit seeds prepared according to the following method was also fed to the vitamin B_1-and B_2-deficient rats and the average weekly growth of each group of test animals was ascertained.

1800 g. of the roughly powdered ripe jack-fruit seeds were refluxed for three hours on the water-bath with a mixture of 3200 c. c. rectified spirit, 800 c. c. distilled water and 40 c. c. strong hydrochloric acid. The reddish-brown liquid was passed through twill cloth and it was then concentrated to a small volume in vacuum on the water-bath. With the addition of a few c. c. of dilute caustic soda solution the pH of the concentrate was raised to 5. It was then filtered and the volume of the filtrate was made up to 500 c. c. This concentrate was preserved in the cold and used in the feeding tests., 2 c. c. of the concentrate were administered to each rat daily - 1 c. c. corresponding to 3. 6 g. of the seeds.

(*a*) The feeding of the seeds produced an average weekly growth of 1. 9 g in B_1-deficient rats and of 3·8 g. in B_2-deficient animals. Thus, 100 g. of the seeds contained 9. 5 units of vitamin B_1 and 19 units of vitamin B_2 (as defined by Guha and Chakravorti[2]).

(*b*) The feeding of the extract produced an average weekly growth of 4. 3 g. in B_1-deficient animals and 7. 5 g. in B_2-deficient animals. 100 g. of the seeds, thus, contained 5. 9 units of vitamin B_1 and 10·4 units of vitamin B_2.

The above results indicate that the ripe jack-fruit seeds are not a negligible source of the B-vitamins, particularly in consideration of their large consumption. The vitamin B_2-content of the seeds is almost twice as much as their vitamin B_1-content. The method of extraction used did not apparently extract the vitamins sufficiently.

My thanks are due to Mr. M. Roy for his careful supervision of the test animals.

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21.5.37.

1. *Indian Journ. Med. Res. 20*, 1045.
2. *Ibid*, *21*, 211.

Studies in Dehydrogenation—Synthesis of 2 : 3-Cyclopenteno-Phenanthrene.

The selenium dehydrogenation of complex spiro-hydrocarbons has been undertaken. By an extension of the method[1] developed by the author for the synthesis of spiro-hydrocarbons, 6 : 7-cyclopenteno-1 : 2 : 3 : 4-tetrahydronaphthalene-2 : 2 spiro-cyclopentane has been synthesised and its dehydrogenation studied. For the synthesis of this spiran, the anhydride of cyclopentane-1-carboxy-1-acetic acid was condensed with hydrindene in presence of aluminium chloride forming mainly $\alpha\alpha$-cyclopentane-β-5-hydrindoyl propionic acid (m. p. 140-141°), which on Clemmensen reduction gave $\alpha\alpha$-cyclopentane-γ-5-hydrindyl butyric acid (104-105°).

LETTERS TO THE EDITOR

This γ-aryl butyric acid on cyclization with 85% sulphuric acid gave the linear product[2] 6 : 7-cyclopetiteno-1-keto-1 : 2 3 : 4-tetrahydronaphthalene-2 : 2-spiro-cyclopentane (m. p. 98-99°), the latter was reduced by the Clemmensen method to 6 : 7-cyclopenteno-1 : 2 : 3 : 4 tetrahydronaphthalene 2 : 2-spiro-cyclopentane (m. p. 64-65°). Selenium dehydrogenation of this spiro-hydrocarbon was attended with ring transformation and was expected to form either 2 : 3-cyclopenteno-phenanthrene or 2 :3-cyclopenteno-anthracene. The dehydrogenation product was obtained as a liquid giving a picrate (m.p. 149-150°) and trinitrobenzene complex (m. p. 128-129°). In order to identify the dehydrogenation product a rational synthesis of 2 : 3-cyclopentenophenanthrene was carried out according to the following scheme. The anhydride of Δ'-cyclopentene-1 : 2-dicarboxylic acid condensed with naphthalene giving a mixture of α- and β-naphthoyl-cyclopentene carboxy acids, the mixture of the keto acids was reduced by the Clemmensen method giving a mixture of naphthyl cyclopentene-carboxylic acids, which on cyclization and reduction gave 2 : 3-cyclopenteno-1 : 4-dihydrophenanthrene. This hydrocarbon on selenium dehydrogenation gave 2 : 3-cyclopenteno-phenanthrene.

The hydrocarbon thus synthesized crystallized in stout needles (m. p. 84°) and its picrate (m. p. 157°) and trinitrobenzene complex (m. p. 162-163°) were found to be different from those of the dehydrogenation product of the spiran. So in all probability 2 : 3-cyclopenteno-anthracene was formed by ring transformation of the spiro-hydrocarbon.

The author has great pleasure in expressing his indebtedness to Dr J. C. Bardhan for his constant and keen interest in the present series of investigations.

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12. 6. 37.

1. *J. Indian Chem. Soc.*, 389 ,1934; *Current Science*, *5*, 295
2. *Current Science*, *5*, 133.

Selenium Dehydrogenation of Tetrahydronaphthalene-spiro-Cyclohexane Derivatives

The selenium dehydrogenation of 1 : 2 : 3 : 4-tetrahydronaphthalene-2 : 2-spiro-cyclohexane, 7-methyl-1 : 2 : 3 : 4-tetrahydronaphthalene-2 2 :spiro-cyclohexane and 7-ethyl-1 : 2 : 3 : 4-tetrahydronaphthalene- 2 : 2-spiro-cyclohexane have been studied. It was found that during dehydrogenation ring transformation occurred with the formation of phenanthrene, 3-methyl-and 3-ethyl-phenanthrene respectively. The equally expected anthracene derivatives that might have been formed by ring transformation could not be detected in the dehydrogenation products. It might be mentioned here that both phenanthrene and anthracene were obtained by the selenium dehydrogenation of tetrahydronaphthalene-spiro-cyclopentane[1]. It is evident that a loss of one carbon atom took place during dehydrogenation[2].

These three spiro-hydrocarbons have been synthesized by an extension of the method developed by the author[1]. The anhydride of cyclohexane-1-carboxy-1-acetic acid condensed with benzene, toluene, and ethyl benzene by the Friedel-Crafts reaction forming $\alpha\alpha$-cyclohexane-β benzoyl-propionic acid (m. p. 117-118°), $\alpha\alpha$-cyclohexane-β-(p-toluoyl) propionic acid (129-130°), and $\alpha\alpha$-cyclohexane-β-(p-ethyl)-benzoyl propionic acid (m. p. 117-118°) respectively. These three keto acids were reduced by the Clemmensen method giving $\alpha\alpha$-cyclohexane-γ-phenyl butyric acid (m. p. 93°), $\alpha\alpha$-cyclohexane-γ-p-tolyl-butyric acid (m. p 99-100°), and α α-cyclohexane-β (p-ethyl) phenyl butyric acid (m. p. 87-88°). These γ-aryl butyric acids on cyclization with 85% sulphuric acid gave respectively 1-keto-1 : 2 3 : 4 tetrahydronaphthalene 2 : 2-spirocyclohexane (b. p. 145°/3mm), 1-keto-7-methyl-1 : 2 : 3 : 4-tetrahydronaphthalene-2 : 2-spirocyclohexane (b. p. 158-160°/4mm.) and 7-ethyl-1 : 2 : 3 : 4-tetrahydronaphthalene-2 : 2 spirocyclohexane b. p. 195-197°/9mm.). The spiro-ketones on reduction by the Clemmensen method furnished the required spiro-hydrocarbons.

The author desires to express his grateful thanks to Dr J. C. Bardhan for his keen interest in this investigation.

Chemical Laboratory, S. C. Sengupta.
Presidency College, Calcutta.
12. 6. 37.

1. *J. Indian Chem. Soc.*, 389, 1934,
2. Compare, Cook and Hewett, *J. Chem. Soc.*, 366, 1934,

On the Constitution of "Artostenone", a Keto-Compound related to Sterols, present in the Indian Summer Fruit *Artocarpus Integrifolia*

By working up the unsaponifiable matter of the milky juice coming through the laticiferous vessels of the freshly cut ripe fruit *Artocarpus Integrifolia*, it has been possible to isolate a solid ketone of the formula $C_{30}H_{50}O$, related to the stenones. The ketone forms beautiful crystals in the form of thick plates from alcohol-ethylacetate-benzene mixture (3 : 2 : 1); and the name 'Artostenone' has been proposed for the substance.

LETTERS TO THE EDITOR

Properties (Chemical & Physical)

Artostenone has a very sharp melting point, 109° and is highly soluble in most of the organic solvents. It is dextro-rotatory and has a low specific rotation of $[\alpha]^{29}_{D} = +19.86$ and $+23.44$ in absolute alcohol and chloroform respectively. Density of artostenone as obtained by Retger's method of suspension is 1.08. The molecular weight as determined by cryoscopic method with benzene as solvent, has been found to be 407; and the molecular elementary composition for carbon and hydrogen, as obtained by Pregl's micro-method, suggests that the molecular weight is 426.

The crystallographic investigation by means of X-rays also corroborates this value, which gives 424 as the molecular weight for artostenone. Artostenone in alcoholic solution shows a strong ultraviolet absorption band at 287 m μ, where the molar extinction co-efficient is 32.40. It gives some of the characteristic colour reactions for sterols. The Kahlenberg's reaction which was supposed to be specific for argosterol has also been shown by artostenone. It gives beautiful needle-shaped crystals of monoxime, m. p. 175° and fine semicarbazone melting at 202°-203°.

Unsaturation

Artostenone is an unsaturated compound with but one double bond in it. The number of bromine atoms which enter a molecule of artostenone, on bromination in carbon tetrachloride solution, is four. Two of these bromine atoms enter the molecule by substitution and the remaining two by addition. The bromo-compound with four bromine atoms has been isolated, and the percentage of bromine, as determined by the method of Píria and Schiff, is 43.4. The correctness of the formula $C_{30}H_{50}O$ for artostenone has also been assured from the combustion figures for carbon and hydrogen of this tetrabromo-compound. The iodine value of artostenone according to a modified Hanu's method is 60.2, one double bond requiring 61.6 as the iodine value.

Reduction

Artostenone is transformed into a saturated compound artostanone (di-hydro artostenone), by method of Willstätter's catalytic hydrogenation with Pt black as catalyst prepared according to a modified method. The method of direct hydrogenation only saturates the double bond and this within 45 minutes but retains the keto group unchanged. Artostanone, $C_{30}H_{52}O$, melts at 106°-107° and forms a fine oxime of melting point 193°-94°.

On saturating the double bond the ketonic absorption is not displaced but the corresponding extinction co-efficient is raised to 53.70.

By reduction with sodium and ethyl alcohol artostenone is converted to artostenol, the double bond remaining intact. Artostenol melts at 106°-107° and its acetyl derivative has a melting point of 119°-20°.

Artostenone differs from cholestenone in its reaction with sodium and amyl alcohol. The double bond remains as it is and the same product as with sodium and ethyl alcohol is obtained. Ultraviolet absorption spectrum of artostenol shows but general absorption.

The behaviour of artostenone towards Clemmensen's reagent is very peculiar. Artostenone remains unchanged even after refluxing for 56 hours with this reagent. The product gives an oxime of the same melting point as that from artostenone.

Kishner-Wolff's method of reduction also proved unsuccessful in the case of artostenone. The saturated hydrocarbon $C_{30}H_{54}$ has however been obtained by the reduction of the saturated compound artostanone, according to the method of Kishner and Wolff. Artostane melts at 101° and forms brown needle-shaped crystals from ethereal solution, melting at 163° with decomposition.

Oxidation

Oxidation of artostenone by means of both neutral and acid permanganate in acetone solution results in the formation of di-keto acid (di-keto artostanic acid) of the formula $C_{30}H_{50}O_4$ which melts at 136°. The molecular weight of this acid as determined by cryscopic method, with benzene as solvent, is 452; the formula requires 458 as the molecular weight. This acid forms fine crystals of dioxime melting at 173° and anilide of melting point, 140°.

By means of oxidation with strong nitric acid a nitro-acid is obtained which contains two condensed rings in the molecule. The acid melts at 157°-158° with decomposition. The molecular weight as determined by cryscopic method is 229.

The method of oxidation of di-hydro artostenone with chromium trioxide in boiling acetic acid solution, gives a keto-acid, $C_{30}H_{50}O_3$ ($C_{31}H_{52}O_3$?) of melting point 88°-89°.

Isomerization

Alcoholic solution of sulphuric acid (5%) converts artostenone into an isomeric compound, α-artostenone, m.p. 99°. The product still contains the double bond and forms oxime which melts at 193°-94°.

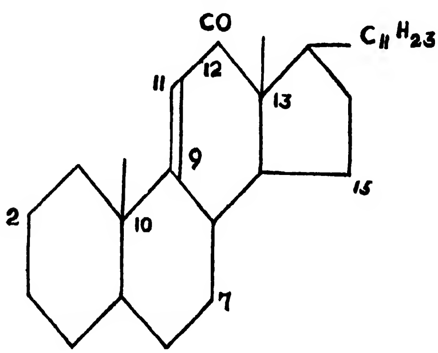
That the tautomerism of the double bond takes place in the reaction is evident from the fact that α-artostenone does not condense with benzaldehyde, whereas the reaction product obtained after treatment with alcoholic sulphuric acid, forms benzylidene compound under identical conditions. A condensation product with benzaldehyde has also been obtained with di-hydro artostenone.

Proposed structure

On the basis of the experimental results and evidences both chemical and physical, as will shortly be published elsewhere, it has been possible to establish beyond doubt that the double bond in the artostenone molecule is in α-β position with respect to the keto-group. It has also been suggested that there are four condensed rings (a pentanophenanthrene grouping) in the artostenone molecule and both the carbonyl group and the unsaturated linking are located in the third ring as indicated below, and occupy the positions C_{12} and $C_{9:11}$ respectively.

The two homeless carbon atoms, are on analogy with other sterols and stenones, assigned to the positions C_{10} and C_{13}.

The structure of artostenone thus stands as :



$C_{30}H_{50}O$ (Artostenone)

Biochemisty Section,
Chemical Laboratories,
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13. 6. 37.

Madhabchandra Nath.

State of Ascoric Acid in Plant Tissues

Elsewhere[1] we have given evidence to show that part of the ascorbic acid in cabbage is probably present in a combined state. This was based on the observation that alcoholic and ethereal extracts of dried cabbage gave increased indophenol-reducing value on heating. Ascorbic acid oxidase could possibly play no part in these reactions and thus no support was lent to Mack's[2] contention that the whole of the increase in ascorbic acid value observed on heating cabbage is to be attributed to the thermal destruction of the oxidase. Further evidence[3] for our view has been afforded by the observation that treatment of cabbage extract with hydrogen sulphide in the hot condition gives a higher indophenol titre than similar treatment in the cold. This can hardly be explained on the basis of the oxidase theory.

Still further evidence has lately been obtained in the following way. Chloroform extracts of dried cabbage were evaporated at room temperature (25°) and taken up in aqueous suspension. These did not give any indophenol titre, showing the absence of ascorbic acid. The aqueous suspensions after heating in nitrogen, however, reduced the dye and a large part of this reducing value disappeared on subjecting the heated extracts to the action of ascorbic acid oxidase (prepared from white gourd) at pH 5.6 at 40° for half an hour, as shown in the following table. The oxidase preparation itself gave no reducing value on incubation. This shows that at least a large part of the reducing value obtained on heating is to be attributed to ascorbic acid or some similar reducing substance, produced on heating, which is oxidized by the ascorbic acid oxidase.

Figures are given in mgm. ascorbic acid per 4 g. dried cabbage

	Heated chloroform extract		
	Before action of oxidase.	After action of oxidase.	Percentage of substance oxidized.
Experiment 1.	0.0416	0.0118	70.6
„ 2.	0.0346	0.0110	68.5
„ 3.	0.0378	0.0120	66.0

Mack and Tressler[4] have now acknowledged that there is a small increase in reducing value on heating, which cannot be explained by the oxidase theory, but they consider that the reducing substance formed is probably not ascorbic acid but some other reducing substance which may be produced by heat from the dehydroascorbic acid present. We had, however, already carried out experiments to show that the chloroform extracts of the dried cabbage did not contain any dehydroascorbic acid, as cold treatment with hydrogen sulphide did not produce any dye reducing substance. So the formation of some reducing substance from dehydroascorbic acid does not arise in this connection.

Of the solvents, ether, benzene, acetone and chloroform, the last has been found to be the best extractant for combined ascorbic acid from dried cabbage. The air dried chloroform extract on being treated with water yields this substance into the aqueous portion whereby very considerable concentration may be effected.

Finally it should be stated that the action of the ascorbic acid oxidase on chloroform extracts, referred to above, may not be regarded as entirely specific for ascorbic acid as other structurally similar bodies may also be oxidized by the enzyme. Biological experiments are in progress in order

(Continued on p. 63 at the end of the second column).

Obituary

MR J. H. FIELD

We mourn the loss of Mr J. H. Field, M. A., C. S. I., who was the head of the India Meteorological Department from October 1924 to March 1928, when he retired after completing his official career of over 23 years as a meteorologist. He had last year undergone a severe operation, but the characteristic fortitude with which he faced the ordeal and the rapidity with which he regained his former health made his numerous friends in India fondly hope that he would yet be spared many more years to further the cause of meteorology. The unexpected news of his death, therefore, has caused a sense of great personal loss to many in the Indian scientific world.

In his school days Mr Field studied classics, and the mental discipline he thus acquired urged him on always to make a passionate bid for meticulous accuracy in whatever he did or attempted in maturer years. After finishing his school career, he studied electrical engineering. The Boer War was, however, responsible for a temporary break in his career. He went to South Africa and the young scientist soon earned praise for himself in the Electrical Section of the Royal Engineers by devising an automatic alarm fence which, on contact, lit flares and rang alarms in block houses. After the conclusion of the Boer War, Mr Field returned to England to complete his studies at Cambridge. At about this time meteorology was gradually emerging from the amateur stage. The need for men with proper scientific training to study the intricate problems of the weather became more and more apparent in the advanced countries, and in India also there was this phase of evolution. It was at the time of Sir John Eliot that Government first decided to let the Meteorological Department recruit a few well-qualified science graduates to assist the Director-General of Observatories. Mr Field was one of the first recruits under this scheme. Before he came out to India in December 1904, he took care to equip himself well for the task ahead. In order to gain first-hand information of the intricacies of upper air soundings, he undertook a balloon

Mr J. H. Field

voyage at Lindenberg and also learnt the technique of kite flying. At that time Mr W. H. Dines had just started his, now famous, upper air investigations in England and Mr Field was not slow to realize the value of this important work. He devoted some time with Mr Dines to gain an insight into the problems of the upper air. It is probably correct to say that in India Mr Field was the first to send up kites fitted with temperature and humidity

recording instruments. In 1905, while testing his kite-winch machines at Karachi, Mr Field discovered that above the surface layer of moist air in that region there was a dry and warm current. During the next two years, kite experiments were undertaken at Belgaum. Mr Field was not satisfied with these desultory observations and took short leave for a voyage across the Bay of Bengal with a view to carry out upper air soundings in that great laboratory of Indian cyclones. It was always a pleasure to listen to the various anecdotes of his quaint experiences while flying kites at various places.

One of the greatest practical difficulties in a Meteorological Department is the reconciliation between the demands of administration and research. The country-wide organization which has to be set up for observation and collection of data involves heavy administrative duties. Again, the collation and interpretation of the data so collected require sustained scientific study and discussion. There is, therefore, always the risk of administration clouding purely scientific issues. Mr Field, as a born experimentalist, had to struggle hard between his own natural inclination of working in laboratories and workshops and the high sense of administrative responsibility as an officer of the department. He, however, never could forget his goal, namely, upper air research and amid his less interesting administrative duties managed to improvise a small workshop in Simla. In this ill-equipped place he designed some very light recording instruments for use with his kites. This was a noteworthy achievement. He also overcame serious difficulties in the measurement of winds aloft under Indian conditions. The rubber balloons used in Europe rapidly deteriorated in the tropics. After a very patient testing of various kinds of materials he substituted gutta-percha and celluloid balloons in place of rubber. His activities, however, were perforce limited on account of financial difficulties, as the Government in those days was not in a position to realize the importance of upper air research. Things looked very gloomy indeed and between 1910-12 Mr Field, in sheer despair, was seriously contemplating resignation. It was chiefly through the good offices of the Royal Society through the Secretary of State for India, that eventually three lakhs of rupees were sanctioned specifically for upper air research and Mr Field selected Agra as the venue for his experimental and investigational activities. This is the history of the establishment of the Aerological Observatory at Agra in 1914 with Mr Field as its first director. It was here that his special aptitude for experimental work found full scope and Mr Field laboured incessantly for a decade to adapt experimental methods of the West to suit Indian conditions. It is to him that we owe the splendid collection of standard meteorolgical data of the upper layers of the free atmosphere over India. His investigations on the relation between the monsoon and the upper winds and the standard exposure of instruments in India will long be remembered in the meteorological history of India.

Mr Field's activities were interrupted by the Great War during which he went to Britain and joined the Admiralty Research Station at Shandon, Scotland. Here he designed an electrical depth recorder for paravanes on mine sweepers. After the conclusion of the War, Mr Field returned to India and resumed his upper air investigations. In 1922 his services had to be requisitioned in the Director-General's office at Simla. Mr Field knew that his duties would be mainly administrative but did not flinch. On the contrary he brought with him his impressive enthusiasm and convincing advocacy to lubricate the administrative machine at Simla. Mr Field's predecessor in the office of the Director-General was Sir Gilbert T. Walker, a mathematician of repute. Under Sir Gilbert's direction the mathematical and physical work done in the India Meteorological Department had received world-wide recognition. It was in the fitness of things therefore that, after the retirement of Sir Gilbert, the mantle of the Director-Generalship fell on Mr Field, a born experimentalist. It is said that an ounce of fact is worth tons of theory and this attitude of mind dominated all actions of Mr Field as the Director-General. His zeal for experimental work has been emulated by many of his staff with the result that the

output of upper air data of the India Meteorological Department now occupies an important niche in world meteorology.

In order to appreciate fully the pioneering nature of the services rendered by Mr Field to the cause of Indian meteorology, one has to remember how he successfully assumed the role of an engineer in connection with the manufacture of hydrogen at Agra and how his unfailing optimism brought him success at last. Here is an instance of what perseverance, endurance, and patience can do.

As the Director-General, Mr Field at once set out to remedy the paucity of gazetted staff in the department. His predecessors certainly felt this handicap very keenly but meteorology had not then come to the forefront. It was Mr Field's personality, his convincing arguments, impressive enthusiasm and power of persuasion, aided by Government's surplus budgets at that time, that made the authorities grant his demands. If we compare the time of Mr Field's entry into the directorship with that of his retirement we find that Mr Field made the following important contributions to the building up of the department, namely,—

(*a*) A rapid expansion of the upper air organization in connection with civil and military aviation,

(*b*) Organization of cyclone work for the Bay of Bengal from the Meteorological Office, Calcutta,

(*c*) A home for Headquarters of the Meteorological Department at Poona,

and (*d*) A substantial increase in the scientific staff of the department.

Mr Field did not relinquish his meteorological work even after his retirement. His services were requisitioned by the Air Ministry, London, to investigate the cause of the so-called "Gibraltar plume". In this work also he exhibited his characteristic thoroughness and foresight by preparing a clay model of Gibraltar and experimenting with it in a wind tunnel before proceeding to determine the characteristics of the wind circulation on the spot.

From what has been said in the preceding paragraphs, it is clear that Mr Field was peculiarly fitted by temperament to be a great experimental meteorologist. His example has been a constant source of inspiration to the staff of the India Meteorological Department who received such guidance in a critical time of intense activity as financial facilities allowed. For this service alone the Indian Meteorologists can never be sufficiently grateful to him. The India Meteorological Department will ever remain indebted to Mr Field for the tireless patience and critical acumen which have characterized both his scientific and administrative activities.

PROFESSOR HENRI DOUVILLÉ

Professor Henri Douvillé, the eminent French palaeontologist, died at his Paris residence on the 7th January 1937 at the age of 91. He was born at Toulouse, a small university town in the south of France in the year 1846. He was educated at first at the École Polytechnique and afterwards at the École de Mines where he came into contact with Professor Bayle, under whose stimulating influence he acquired a deep interest in invertebrate palaeontology. In 1875 he began systematic research work with Professor Bayle and was soon entrusted with the task of organizing the collections of invertebrate palaeontology at the École. Within a short time he made a mark as an able worker in his subject so much so that at the retirement of Professor Bayle he was asked to occupy his chair at the École which he occupied right up to his death.

Some of his works are now classic in their own sphere. Reference should be made in this connection to his now famous work on the group of Rudiste fossils. His studies not only cleared up many complicated problems regarding their phylogeny but also revealed an interesting correlation between the variation in the number of their species and the change of physical environment throughout the whole geological period in which they flourished. Equally well-known and important is his work on Orbitoline and Lepidocycline found in the Mésogée"

(a term given by him to the sea generally known as Tethys) in which he propounded, among others, that the hot water of the Méssogée was probably the cause of the separation of Europe from the African Continent.

Douvillé's reputation as a palaeontologist spread far and wide so much so that his expert opinion was, of and on, sought even from foreign lands whenever any difficulties arose concerning the identification of any unknown fossil, its age, etc. Reference is to be made in this connection to his works in Panama, Madagascar, East Indies, and even India.

In Indian Geology his name will be long cherished for his two masterly memoirs (not to mention other minor publications) published by the Geological Survey of India:

(1) La crétacé et l'éocene du Tibet centrale.

(2) Les couches à Cardita Beaumonti.

(*Pal Ind.* New set, Vol. X. Mem 3.

He was universally esteemed for his *bon homie*, honesty, and above all, sympathy towards the young workers. His main formula for life was 'work' and even up to his last days he kept his strength both in mind and body. The present writer who had the opportunity of working with him on the micro-fossils collected from the French Alps was astonished, like many others, to find him working, even at this advanced age, six or seven hours a day and without spectacles. In recognition of his works he was elected to the much-coveted membership of the Institut de France.

S. Deb.

(*Continued from page 59*)

to test this question further and it cannot, therefore, be definitely stated yet that the substance produced on heating is ascorbic acid. But there is no doubt that there is in cabbage a precursor which produces an indophenol-reducing substance on heating under our conditions of experiment.

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B. C. Guha.
P. N. Sen Gupta.

22. 6. 37.

1. Guha and Pal, *Nature*, *137*, 946, 1936.
2. Mack, *Nature*, *138*, 505, 1936.
3. Guha and Pal, *Nature*, *139*, 811, 1937.
4. Mack and Tressler, *J. Biol. Chem.*, *118*, 740, 1937.

SCIENCE AND CULTURE

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On the National Supply of Electricity

In two articles published in SCIENCE & CULTURE (Vol.1, p.303, and p.367, 1935), we gave our readers some idea of the importance of the question of supply of electricity to the public for domestic and industrial purposes. The subject is, however, of such great importance that we make no apology for returning to it at the present moment.

In these two articles, we pointed out that in the matter of consumption of electricity per head, India stands almost on the same level with China and Abyssinia; her present figure is between 6 to 7 units *per capita*, while that of an advanced country like Canada is about 1800 units *per capita*, and that of Mexico, which is pointed out as a model of misrule and medievalism, 91 units *per capita* of her population. If consumption of electricity *per capita* is taken as a measure of civilization, India stands almost at the bottom of the scale.

It may be argued that the backwardness of India is due to non-existence of electrical power resources in the country. This is however far from being true. Sir M. Vishweshwarayya, ex-Dewan of Mysore, in his thought-provoking book *Planned Economy* (1933), has shown that barely 3% of India's hydro-electric power resources have so far been developed. In most progressive countries, 70 to 80 per cent of the resources are usually developed. Supply of power is the essential condition for industrial progress in this century, and no government which neglects this line of activity can be said to discharge its functions properly.

Electrical Power Resources

It may be argued that the power resources have not been developed, because there is no demand for it. This is again far from being the case. The country wants to be industrialized but industrialization cannot be put on an economic basis unless there is cheap supply of power. The real reason for India's backwardness in this respect is the absence of a definite policy on the part of the Government for developing her power resources, and absence of beneficent legislation to meet this end.

We shall illustrate our case by considering the supply of electricity to the City of Calcutta. The generation and supply of electricity for the City of Calcutta and its suburbs is entrusted to the Calcutta Electric Supply Corporation, a Company with its head office at London, and with Lord Meston, ex-Governor of the United Provinces, as Chairman. This Company has a capital of 2·8 million pounds (taking into account shares and debentures of all kinds), and has been paying a dividend of 12 to 15% for a number of years. It has installed generation plants having total capacity of about 80,000 kilowatts, and sells about 256 million units of electricity

per year. The dividend is no index to the profit made by the Company, for the directors all enjoy fabulous fees, and about 20 to 30% of the capital goes to the reserve fund and to meet depreciation charges. Protected by paternal government legislation, it holds monopoly in the Calcutta area in the matter of electric supply, and real profits amount to nearly as much as the capital.

The rates were originally 3 annas per unit for domestic consumption which has, as a result of persistent agitation, been reduced to two annas.

How high the Calcutta rates are compared to European rates will be clear if we take the case of the London area. There is justification for this comparison, as the conditions are almost identical in the two cities. The electricity rates are determined by the proximity of the station to the coal area (provided electricity is generated from coal, as is the case both in London and Calcutta), the density of population in the supply area, and the demand for electricity. The last two conditions do not differ much in the two areas. Yet the Londoner gets his unit of electricity for domestic purpose (light and fan) at about half the Calcutta price, for industrial purpose at ¼d per unit, and for all electric houses (light and cooking) ⅓d per unit. The Calcutta man pays 2 annas (2.2d) for domestic purpose, and other rates are proportionately higher. In other words Calcutta rates are about twice as high as those of London. Such high charges are entirely unjustifiable.

About two years ago, the Bengal Government, in response to persistent popular agitation, appointed a Committee presided over by Sir N. R. Chatterjee to enquire into the question of tariffs. The personnel of the Committee did not inspire confidence as it was composed only of commercial and legal experts and the public was not allowed to send representatives having knowledge of electricity and of tariff problems. This Committee recommended a paltry reduction of one pice (¼ anna) on the existing rate 2½ annas per unit, but the Supply Company very generously condescended to reduce the rates by half anna per unit. This act of grace by the Calcutta Electric Supply Corporation has not been appreciated by the committee of the Calcutta Corporation which was appointed to examine the recommendations of the Government Committee. In course of a press *communique*, the Committee says that the rates charged have hardly any economic basis, and that it is only through apprehension of a curtailment of their supplies, or through insistent agitation that the charges can be reduced.

By way of illustration it is stated that the Corporation of Calcutta had been charged 2½ annas a unit for institution lighting. When sanction was given to Dr B. N. Dey's plan to provide electricity at one pice a unit the Electric Supply Corporation is described as having offered to reduce their rate of 2½ annas to a sliding scale for bulk supply of a little over three pice a unit.

This reduction, adds the report, applied to large consumers who used a minimum of 1,00,000 units a year. It certainly revealed, if anything, that the previous high charge of 2½ annas a unit had no economic basis.

On an examination of the figures and accounts placed before the Government Inquiry Committee, it continues, "it is abundantly clear that the recommendations of that Committee have been halting and far short of the reduction warranted by the facts found by them.

"It is difficult to realize how a paltry reduction of only half an anna could be recommended as immediate relief."

The Committee is of the opinion that the capital expenditure of the Company is too high and points out that undue or over-capitalization invariably reacts on the ultimate price of the unit.

"Take, for instance, an index of present charges: a recent estimate submitted by the Company of labour and petty materials covering a lead of less than 400 feet of cable-laying was put down at Rs 4,000. Normally the Calcutta Corporation have similar work done under similar conditions at a tenth of the charge—Rs 400.

"The high additional remuneration over and above the ordinary remuneration, totalling £12,200

paid as directors' fees, and £8,609 for the London establishment and other expenses tend to raise the level of expenditure disproportionately high.

"The Government Inquiry Committee, therefore, had no justification to recommend a return of 7 per cent on the net assets of the Company."

In view of the fact that the Company's undertaking is well-established, possessing a virtual monopoly and protected by statutory safeguards, this Committee considers that a return of 6 per cent on the capital receipts, *viz.*, £3,959,529, would be fairly generous.

Regarding the Obsolescence Fund the Committee feels that no case has been made out for its continuance in view of the existing Reserve and Depreciation funds which are large enough to serve the purpose for which the Obsolescence Fund stands.

It is recommended that the whole of the amount concerned, £50,000, should be applied to the reduction of the rates.

Management costs "are inflated enough," the report goes on, to bear a reduction of at least 25 per cent as against 15 per cent recommended by the Government Committee. In eight years, it is stated, this item has increased 100 per cent.

The reductions proposed above under the various heads are likely to render an amount of £369,447 available for reduction of the rates for lights and fans to the level of one anna a unit at once, leaving a sufficient margin of relief to other consumers.

If is held by the Committee that the reductions recommended by the Government Committee are not commensurate with the financial position of the Company, and that there is ample scope for further reduction up to at least one anna a unit for lights and fans.

If the rate is not reduced to this figure, the Committee propose that the Calcutta Corporation purchase the undertaking covered by the Calcutta licence and lease it out, strictly on the basis of a one-anna-a-unit tariff, to a reliable firm at a premium equivalent to the amount of consideration money.

The Company having, in spite of the statutory obligation to the contrary, mixed up the accounts of the various licences held by them, it is not possible to ascertain the actual value of the properties covered by the Calcutta licence.

The total unexpired value of the properties and service on the basis of 1931 figures is £1,613,251 covering in all 14 licences held by the Supply Corporation. Of these, the Calcutta licence being the oldest, a major portion of the assets has been written off for depreciation.

That being so, the actual value of the undertaking which the Corporation will have to pay under the Indian Eletricity Act cannot be more than £1,000,000.

This method has the advantage of controlling the price of the unit retailed to the consumer and exercising a superior supervision of the working of the undertaking by the lessee without any direct responsibility resting on the Corporation.

The Committee have not been able to examine the proposition in greater detail which can be considered by another committee which can also settle the terms and conditions of the lease if the Corporation accepts the proposal of this Committee of exercising their option to purchase the undertaking and grant the lease to a reliable firm.

In an annexure to the report the Chief Engineer of the Calcutta Corporation remarks that "through the precept and example of the Calcutta Corporation, the Electric Supply Corporation have gradually reduced their once 'irreducible' domestic rates (for lights and fans) of three annas a unit to the current rate of two annas a unit." The Engineer proceeds :

"Even so, the rate still falls short of the tariff proposed by the Calcutta Corporation—one anna a unit.

"The easiest way to secure this rate is to make the Company accept it.

"Failing this, there are two courses open. The Calcutta Corporation or the Government may purchase the undertaking and run it as a municipal or State department,

"The second course is to get some other Company to act as the Agent of the Calcutta Corporation, purchase the undertaking and work it as lessee to the municipal body, with the one-anna tariff as one of the terms.

"If and when the latter course is decided upon I shall put up the details regarding terms and condi-

tions of the Agency as well as the draft advertisement calling for offers.

"Another mothod for securing cheap rates would be for the Calcutta Corporation to purchase electricity in bulk from the Company and distribute it. This method is in vogue in Madras. For this purpose the existing cable lines and substations will have to be taken over from the Company at an agreed price.

"The cheapest domestic rate for lights and fans—much cheaper than one anna a unit, however, can be secured if an altogether new undertaking is built up to supply the area limited by the Calcutta licences, and the undertaking run and managed by Government or the Calcutta Corporation. To do this special legislation will be necessary."

We are in entire agreement with the opinion of the Municipal Committee, and wish them good luck in their struggle with the Calcutta Electric Supply Corporation. But we wish to point out that the problem of development of electrical power and its supply should be more vigorously tackled by the national Governments which are coming into power. In Great Britain, as in every other advanced country, the government controls completely the generation of electricity; its distribution is left to private companies under conditions which reduce profiteering to the minimum extent. India, in this as in many other matters, is about quarter of a century behind, and conditions are similar to those prevailing in the United Kingdom before 1918.

What are the successive steps by which profiteering in electricity has been stopped in Great Britain? We quote the words of the Government Committee on Electricity Distribution appointed in July 1935, with the following terms of reference.

To bring under review

(*a*) The organization of the distribution of electricity in Great Britain, including control of statutory electricity companies by other companies.

(*b*) To advise on methods by which improvements can be effected with a view to ensuring and expediting the standardization of systems, pressures, methods of charge, etc.

Previous to this committee, the subject had been investigated by a number of committees, the most important being the Weir Committee of 1926.*

Legislation relating to electricity supply commenced with the Electric Lighting Act of 1882, which was revised in 1888, 1898, 1900 (Power Companies Act), 1919, 1922, 1926. In India, there has been no revision of legislation (except minor ones) since the Electricity Act of 1924. The result of the various legislations in Great Britain is seen in the following figures.

	Units sold to consumers		
Sale of electricity	1920 21	1933 34	1934-1935
Lighting, heating, cooking	582 millions	3916 millions	4535 mill.
Power	2499 „	6392 „	7285 „
Charges			
Lighting, etc.	5·77d	2·28d	2·13d
Power	1·69d	0·73d	0·69d
Overall average revenue per unit	2·48d	1·26d	

The rates for London are considerably (nearly half) lower than the average. There are 15 undertakings in England, *all State-owned*, which charge less than 1·5 d per unit, for domestic purpose, less than ·5 d for power. The figures show that Indian consumers are still paying the rates which used to hold in the U. K. nearly twenty years ago.

We advise the National Governments which are coming into power to appoint committees for investigation of generation and distribution of electricity with the same terms of reference as the Weir Committee of 1926, and the McGowan Committee of 1935.

*It may be mentioned that the Weir Committee (appointed in 1926) recommended complete State control of Generation of Electricity which was carried into effect by legislation in 1927, and is effected by the development of the Grid System.

On the Nature of Laterite and Lateritic Soil

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Processes of Soil formation and Soil Profile

THE study of soil is closely connected with agriculture. Thanks to the efforts of eminent scientists, chiefly of the Russian school, the investigation of soil has now become a definite branch of study to which the name "Pedology" has been applied.

It is well known that soil is formed from the weathering of rocks. Weathering may be either physical or chemical in nature, chemical weathering being the more important of the two. The chemical decomposition of rocks takes place in an aqueous medium and depends on the decomposing action of rain water, of carbon dioxide dissolved in the rain water, and of organic acids produced by the decomposition of plant residues. The mineral silicates are hydrolysed with the simultaneous liberation of silicic acid and the hydroxides of the bases present. Whilst the alkaline and alkaline earth hydroxides are soluble in water, the silicic acid and the hydroxides of aluminium and iron may form colloidal solution. Silicic acid sols are electronegative whilst the sesquioxide sols are electropositive, and mutual precipitation may occur giving rise to the weathering complex of definite or probably of indefinite composition[1]. After the rock minerals have undergone appreciable physical and chemical weathering, the inorganic products of weathering and the organic matter differentiate into definite horizons, under the influence of water movements within the soil. The complete succession of such soil layers down to the parent rock is called the soil profile, which represents the results of all the soil-forming processes and is recognized as the natural unit of study in soil classification.

1. S. Mattson, the Laws of Soil Colloidal Behaviour IX, *Soil Science*, *36*, 149, 1933.

Laterites and the Process of Laterization

The weathering of rock minerals takes place to different extents according to different climates. If the weathering occurs under conditions of high temperature and heavy rainfall, as it does in humid tropical regions, humic acid is oxidized as rapidly as it is formed with consequence that silica is leached out in preference to sesquioxides. The soil thus becomes rich in the hydrated oxides of alumina or iron and acquires red colour due to presence of red-coloured iron oxides. Such soils are usually known as *laterites* or *lateritic* and the process is called laterization. Laterites and lateritic soils occur abundantly in the Indian Deccan, Africa, British Guiana and in Australia.

It will perhaps be interesting to give a short account of the origin of the term "Laterite". It is the equivalent of the term "itica cullu" of the dialect of Malabar, in South India, meaning 'Brickstone'. The name "Laterite" was at first used by Francis Buchanan (who was later known as Buchanan-Hamilton) for some hard red soil from Southern India, specially in the Malabar district. Regarding the nature of this material, Buchanan writes - "It is one of the most valuable materials for building. It is diffused in immense masses, without any appearance of stratification, and is placed over the granite that forms the basis of *Malayala*. It is full of cavities and pores, and contains a very large quantity of iron in the form of red and yellow ochres. In the mass, while excluded from the air, it is so soft, that any iron instrument readily cuts it, and is dug up in square masses with a pick-axe, and immediately cut into the shape wanted with a trowel, or a large knife".

It may be interesting to mention in this connection the relation between the terms 'laterite' and

'bauxite'. The latter name was given in 1821 by P. Berthier to a peculiar *clayey* substance which had been formed at Les Baux near Arles in Provence (France). On analysis the substance was found to contain 52.0 p.c. alumina, 27.6 p. c. ferric oxide and 20.4 p. c. combined water[2]. The double nomenclature of 'laterite' and 'bauxite' continued to the end of the last century, when Max Bauer[3], working in the Seychelles proved that bauxite is a variety of laterite. T. H. Holland however thinks that Dr H. Warth must be given "the credit of having first, or at any rate independently, suspected laterite and bauxite to be essentially similar"[4]. It must be recognized however that though interesting from a scientific point of view, the laterites are not of economic importance for the purposes for which aluminium ores are used.

Description of Laterite Profile

From morphological point of view a typical laterite consists of four horizons from below[5], *viz*. (*a*) parent rock material succeeded by (*b*) a horizon in which the material is non-lateritic and the immediate product of primary weathering, (*c*) the horizon of laterite proper which passes into (*d*) surface horizon characterized by ferruginous incrustation or concretions. The ferruginous incrustations on the surface are frequently occasioned by intermittent rainfall with consequent alternate excess of evaporation and precipitation or by conditions of oscillation of the water-table yielding alternations of saturation and desiccation.

Chemical Nature of Laterite and of Lateritic Soils

According to Fermor[6] a true laterite should consist of at least 90 p. c. of what he calls 'lateritic constituents', *i. e.*, oxides and hydroxides of iron, aluminium, titanium and sometimes manganese. These lateritic constituents are the residual accumulations after the combined silica, lime, magnesia, soda and potash have been removed in solution from the superficial decomposition products of rocks. Fermor suggests in this connection that "many rocks to which the term 'laterite' has been applied, could be more aptly termed soils, earths, clays and sands with (> 25 per cent) or without (< 25 per cent of lateritic constituents) the attributive 'lateritic'".

Martin and Doyne[7], on the other hand, define laterite and lateritic soils by low values of silica-alumina ratios of the clay fractions, for laterite the ratio being 1·33 or less, whilst for lateritic soils the ratio lies between 1.33-2.0. A low value of the above ratio implies the presence of free alumina. The following table will illustrate the chemical composition of the clay fractions of some typical laterite and lateritic soils.

TABLE 1

The chemical composition of the clay fraction of some typical laterite and red earths.

Material	Locality	Reference	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	Silica/Al_2O_3 ratio molecules.
Laterite	Sierra Leone	Tech. Communication No. 24, Imp. Bureau of Soil Science, 1932, p. 13	18.7	28.7	9.6	1.10
Red Earth	Tanganyika	Robinson Soils, Ed.	40.5	30.6	17.6	2.25
		1932, p. 274.	44.4	33.9	17.8	2.23

Martin and Doyne regarded the presence of iron oxide in the clay fractions as not being essential to the formation of lateritic soils. G. W. Robinson[8] and F. Hardy[9], however, think that iron oxides play

2. C. S. Fox, The Bauxite and Aluminous Laterite Occurrences of India, *Memoirs of the Geological Survey of India*, *49*, Part I, pp. 2-3, 1923.

3. *Neus. Jahrb. fur Min.* etc, vol. II, p. 201, 1898.

4. T. H. Holland, On the constitution, Origin and Dehydration of Laterite, *The Geological Magazine*, Decade V. X. p. 59, 1903.

5. G. W. Robinson, *Soils*, p. 279, 1932.

6. *Geological Magazine 8*, p. 565, 1911.

7. *J. Agric. Sci.*, *17*, pp. 530-547, 1927.

8. *Nature*, *121*, pp. 903-904, 1928.

9. *J. Agric. Sci.*, *21*, pp. 150-166, 1931.

important roles in the clay fractions. There are also several observations in the literature showing that some soils may be very deficient in free alumina and yet be very similar to the laterite as defined by Buchanan. Thus Scrivenor[10] has shown that although the soils of the Malacca Territory are very similar to the type of laterite as defined by Buchanan, practically all the alumina present is combined with the silica. Indeed, Scrivenor finally suggested that the term laterite be no longer used in scientific work. As a consequence of numerous divergent results in the literature, it is generally admitted that the definitions of laterite and lateritic soils are rather vague. Dealing with some aspects of tropical soils, F. Hardy[11] writes "Evidently the present usage of the term laterite by pedologists is inexact, and the modern definition has come to mean a highly aluminous and highly hydrated residual rock product, usually also rich in hydrous iron oxides and containing other characteristic components. It has been used in this sense by Harrison, by many other early soil investigators and geologists." Mention may be made here of the views of H. Warth and F. J. Warth,[12] who, as a result of their detailed chemical examination of many typical Indian laterites, write: "Further, the results show that the term laterites has a distinct meaning throughout the many varieties of this rock. Laterite is bauxite in various degrees of purity, from the richest wocheinite down to such specimens in which the free alumina has entirely disappeared."

The petrological and chemical investigations of the Late Sir John Harrison[13] in British Guiana have added considerably to our knowledge of the origin of laterite and lateritic soils. As a result of his laborious work, Harrison came to the conclusion that the lime felspar components of a basic igneous rock like dolerite are transformed by the process of weathering into crystalline gibbsite, silica and lime; also the ferromagnesian minerals, mostly pyroxenes, are converted by weathering into yellow, orange or red hydrous iron oxides. Kaolin is almost entirely absent in this weathered soil layer which Harrison designated as "Primary Laterite". The gibbsite component of this primary laterite may be resilicated under the influence of the fluctuating ground water carrying dissolved silica and bases under impeded drainage conditions. Harrison called this product "secondary laterite" which is also sometimes known as "red earth" or "lateritic soil". Harrison's work also showed that the "secondary laterite" is usually produced by the weathering of an acidic igneous rock like granite under humid tropical conditions. In this case potash felspar is converted not into gibbsite, as in the case of lime felspar, but directly into kaolins. The soil thus originated may be coloured red by hydrous iron oxides and may closely resemble the 'red earth' or 'the lateritic soil' derived by the resilication process in the weathering of the basic rocks.[14]

Red Loams

There is a third type of red tropical soils, known as red loams[15] which are comparatively young soils, *i. e.*, in which the weathering changes are not far advanced. The clay of this soil type is rather siliceous in nature.

Thus, to sum up, three types of red-coloured soils under humid tropical conditions may be differentiated: (1) younger red earth or red loam or sometimes known as lateritoids*[16] (2) older red earth or lateritic soil or sometimes known as secondary laterite and (3) fully matured laterite or sometimes known as "primary laterite".

Process of Laterization

C. F. Marbut [17] postulated that lateritization is a geological process of rock decomposition and not

10. *The Geology of Malaya*, p. 153, 1931.

11. *Trans. Third International Congress of Soil Science*, 2, p. 153, 1935.

12. *The Geological Magazine*, Decade, IV, p. 155, 1903.

13. The *Katamorphism of Igneous Rocks under humid tropical condtitions*, Imperial Bureau of Soil Science, 1934.

14. F. Hardy, *Trans. Third International Congress of Soil Science*, 2, pp. 150-163, 1935.

15. G. W. Robinson, *Soils*, p. 317, 1936.

16. B. B. Polynov, "*Contribution to the knowledge of the soils of Asia*, 2, published by the Academy of Sciences of U. S. S. R. p. 6, 1932.

17. *Abstracts of Proceedings of Second International Congress of soil Science*, Commissions, IV, V, and VI, p. 63, 1930.

a process developing a soil profile, and has no greater claim to be considered a soil developing process than kaolinization or siallitization. This suggestion of Marbut is somewhat similar to that of Polynov[18] who thinks that the weathering of mountain crystalline rocks and the formation of soils are quite distinct processes. Laterite, according to Polynov, is final of the geological weathering of mountain crusts, while lateritic soils and tropical podsol are superficial soils formed on the weathering products. Mention may be made in this connection of the views of Prescott[19] who thinks that the typical laterites of Australia are the fossil alluvial horizons of an ancient soil. The original alluvial horizon must have been removed by denudation process. When once the surface horizon has been removed, the persistent iron stone horizon would weather very slowly and only under heavy rainfall conditions would it either break down to a new soil or be entirely denuded away. It might be of interest to investigate whether such type of fossil laterite occurs in any part of the Deccan Plateau.

Properties of Laterites and Lateritic Soils

Lateritic soils have well-known physical properties, such as marked friability, high permeability and small residual shrinkage[20]. As a rule, lateritic soils are poor in plant nutrients, especially phosphate and potash. But they respond well to cultivation, mainly because of their favourable physical characteristics. Lateritic soils can be maintained at a high level of fertility by deep ploughing and by the addition of organic manures.

Laterite and Lateritic Soils of India

Laterite regoliths usually occur on the summit of the basaltic hills and plateaus of the highlands of the Deccan, Central India and Central Provinces. In all these places laterite usually occurs at height varying from about 2000 ft to 5000 ft capping the highest flows of the Deccan Traps. This type of laterite is also known as 'rock-laterite', *in-situ* laterite' etc.—terms meant to convey the meaning of 'primary laterite'[21]. In thickness these laterite caps vary from 50 ft to nearly 200 ft. Laterite, which scarcely occurs on situations below 2000 ft above the sea level, is known as high-level laterite, the rocks of which are characterized by massive homogeneous grain and of uniform composition. The above type of laterite is thus differentiated from what is known as the *low-level laterite* which occurs on the coastal low-lands on both sides of the peninsula. Low-level laterite is usually formed of the products of mechanical disintegration of the 'high-level' laterite and is, therefore, of detrital origin. Low-level laterite is also sometimes known as 'detrital', 'reconsolidated' or 'secondary laterite'[22]. As regards both its structure and composition, Indian laterite shows a great deal of variation from place to place[23]. Regarding the causes of origin of Indian high-level laterites the general view[24] is that they are simply the result of alteration *in situ* of various rocks, mostly basalts by the action of atmospheric changes.

The date of the existing high-level laterite cap in the Deccan is not determinable with certainty; in part it may be Pliocene, or even older, in part its age is Pleistocene or even somewhat earlier, and it is probable that some of it may still be forming at the present day. Since, in general, the low-level laterite has been formed from the high-level laterite, it necessarily follows that the former, *i.e.*, the coastal laterite must obviously be still younger.

In 1933, Dr C. S. Fox visited the Malabar and Kanara districts with the object of re-examining Buchanan's laterites and of ascertaining definitely their composition. In a recent publication dealing

18. B. Polynov, *Trans. Third International Congress of Soil Science, 1*, pp. 327-330, 1935.

19. Council for Scientific and Industrial Research, *Bull.* 52, p. 48, 1932.

20. F. Hardy, *Trans. Third Internatl. Congress of Soil Science, 2*, 152, 1935.

21. C. S. Fox, Bauxite and Aluminous Laterite Occurrences of India, *Memoirs of the Geological Survey of India, 49*, Part I, p. 3, 1923.

22. *Ibid.*

23. D. N. Wadia, *Geology of India*, pp. 257 261, 1919.

24. R. D. Oldham, *Geology of India*, p. 379, 1893.

with this subject the chemical analyses of laterite soils, as given by Fox[25], show clearly that Buchanan's original laterite consists mainly of what we should now call lithomargic laterite and even in part laterite lithomarge. The table above (No. 2) taken from his paper (p. 400) will indicate the chemical nature of Buchanan's laterites.

In this table amounts of silica, *insoluble* and *soluble* in sulphuric acid, represent respectively the *free* and *combined* silica. It must be recognized however that from the chemical point of view such differentiation between free and combined silica is purely arbitrary, although they often yield very valuable information. The data in the above table show that there is considerable amount of total silica in the soil, most of which is in the

TABLE 2

Laterite from Cherovannur quarry.

	No. 1 (Top). (Reg. No. 47/287.)	No. 2. (Reg. No. 47/288.)	No. 3. (Reg. No. 47/289.)	No. 4. (Bottom). (Reg. No. 47/290.)
Residue insoluble in H_2SO_4				
Quartz " "	4.32	8.99	11 61	23.27
Granular feldspar	2.35	3.46	2.03	2.39
Total	6.67	12.45	13 64	25.66
Soluble in H_2SO_4.—				
SiO_2 ..	17 08	20.90	21.08	26 56
Al_2O_3 ..	20 83	18.64	21 40	16.57
Fe_2O_3 ..	39.09	33 23	26 30	16.63
FeO ..	0 98	0 92	1.07	1 72
MgO ..	Nil	Nil	Nil	Nil
CaO ..	0 30	0.28	0.56	0 28
Na_2O ..	trace	trace	trace	trace
K_2O ..				
MnO ..				
P_2O_5 ..	0.07	0.09	0.09	0.07
TiO_2 ..	1.72	2.00	2 44	2.50
Loss at red heat	11.05	10.19	11.04	8.44
Loss at 105°C ..	2.49	1 89	1 96	1.72
Total ..	100.28	100.59	100 38	100.15

25. C. S. Fox, Buchanan's Laterite of Malabar and Kanara, *Records of the Geological Survey of India*, Part 4, p. 389, 1936.

soluble or combined form. The above data suggest that the material is lithomargic laterite, rather than the finished laterite of the Deccan obtained from basaltic lavas. For the sake of comparison the composition of 8 specimens of typical laterites *in situ* are shown in the following table :

lateritization, has been entered." Regarding the applicability and use of the term "laterite" Fox concludes (p. 419) : "Thus the term *laterite* is a convenient field term for uncertain material like that of Malabar where the characteristic texture alone is a guide and a well-established term for the more mature laterites, whose chemical characteristics agree with Sir L. L. Fermor's definition". In other

Table 3

(Ref. The composition of Indian laterite By H. Warth and F. J. Warth, *The Geological Magazine*, Decade IV, X, 1903, p. 155).

	Marwara	*Mahab.*	*Satara*	*Nilgris*	*Nilgris*	*Pulsa*	*Karad*	*Satara*
H_2O	26.82	24.99	23.88	20.70	19.00	15.87	11.82	14.39
Quartz SiO_2	—	—	--	—	10.52	—	1.77	--
SiO_2	3.90	.72	.37	3.14	.23	3.56	4.20	.90
TiO_2	.38	.42	4.45		.10	.13	.10	1.59
CaO	.35	.00	.86	--	.40	.52	nil	.64
MgO	—	—	-	—	—	trace	trace	.20
Fe_2O_3	13.75	23 41	26.61	37.88	34.37	47.27	51.25	56 01
Al_2O_3	54.80	50.46	43.83	28.28	35 38	32.65	30.86	26.27
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

From what we have seen so far it is evident that the term 'lateritization' signifies the end process of weathering beyond that of kaolinization. Fox, therefore, holds the view that there can be rocks representing all the intermediate stages, from the formation of kaolin or lithomarge to the finished laterite which is practically devoid of silica and consists of aluminium hydroxide and ferric hydrate as the two essential components. When the aluminous component is in excess and above 50 per cent of the rock, it is called *aluminous laterite* or *bauxite*, while if the ferruginous component is in excess, it is known as *ferruginous laterite* or *iron clay*. In the light of these considerations Fox has stated (p. 419) : "Neither of these conditions is fulfilled by Buchanan's laterite, yet the vermicular texture belongs to laterite and evidently may be taken as an indication that though kaolinization has been operative, the final stage, that of

words, Fox has suggested that while the term 'laterite' can be used in a comprehensive sense, the more finished products should be more precisely termed '*laterite*' whilst the red soil of the Malabar coast which Buchanan originally designated as '*laterite*' must in the main be regarded as *lithomargic laterite*, meaning thereby a comparatively unfinished product.[26]

The various considerations set forth above illustrate, that although the actual nature of so-called laterite and lateritic materials is more or less well known, the definition of 'laterite' is still in a fluid condition.*

26. Cf. the views of Sir, L. L Fermor, C. S. Fox, *loc. cit.* p. 390.

* From a lecture delivered at a meeting of the Indian Chemical Society held at the University College of Science, Calcutta, on April 23, 1937.

Silk Industry in Bengal

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Different Kinds of Silk

THE silk industry comprises four different kinds of silk produced by four different kinds of silk-worms, two of which are wild and two domesticated. The important one of the two wild ones is *Tasar*.

Wild silk—Tasar: The eggs are tied on the food trees, which too are wild, *viz.*, *asan*, *sal*, etc. The semiwild *kul* (*Zizyphus*) is also a food plant though less suitable. The worms feed on the leaves at will and, when full grown, spin cocoons on the trees. The cocoons are collected and sold. Chotanagpur is the principal tasar-producing tract with the neghbouring districts lying within the jurisdiction of the Central Provinces, Orissa, Behar, and Bengal. Santals and other tribes rear the worms which have to be watched and guarded against birds and other enemies which take a heavy toil. On the average about one-tenth of the number placed on the trees is collected as cocoons. Some breeding takes place naturally in the forests, and the naturally formed cocoons are searched out and sold. The best and largest cocoons are produced by natural breeding in this manner. Tasar weavers purchase the cocoons, and their womenfolk reel out the thread from them in the midst of their household work. Other women too do the reeling on payment. The cocoons are soaked in hot water, and a continuous filament up to about a thousand yards in length can be unwound from them. In practice the filaments of several cocoons are pulled out together and wound on a *latai* and some twisting is given to the yarn by being rubbed on the thigh of the reeler as it passes from the cocoons to the *latai*. The yarn is then used in weaving fabrics. Tasar weaving is an important industry in several places in Bengal, especially in Bankura and Birbhum districts. As the worms are not wholly under control there is a limit to the expansion of the tasar-producing industry.

Wild silk—Muga: The other wild silkworm is *Muga* which is allied to tasar and occurs in Assam and is reared practically in the same way as tasar, and utilization of the cocoons is also effected practically in a similar manner. Much expansion of the muga-producing industry too is not possible.

Domesticated silkworms—Endi: Of the two domesticated silkworms one is called *eri*, *endi* or *erandi*, the name being derived from the food-plant of the worm which is *eranda* or castor.

The worms are kept on trays, tended and fed indoors. When full-grown they are placed among dried leaves or straw in which they spin cocoons. A continuous long filament cannot be obtained from the cocoon as in the case of muga and tasar. The cocoon has to be spun into thread more or less like cotton, and spinning is done with the simple hand spindle, variously called *taku*, *takuri* or *takli*. The thread is woven into *thans* or *chadars* with which most people are familiar.

Eri rearing and spinning is a smallscale cottage industry carried on almost wholly by old women. A few (usually about 15, 20, or 30) castor trees are grown on homestead lands or embankments, and small lots of worms are reared at a time. Spinning of the thread is done by the rearers themselves. Hand-spinning machines have been devised, but the spinners are generally too poor to adopt them. A *taku* costs nothing. Also spinning with *taku* can be done anywhere, for instance, while tending cattle or gossipping or even when walking on the road.

Eri-rearing and spinning industry is confined to Assam and the eastern districts of Bengal, *viz.*, Bogra and Rangpur. From information collected in Bogra district it appears that the annual earnings of

142 persons are about Rs 15 per head on the average, though some individuals have as much as Rs 40. The yarn is purchased by Marwari merchants who export it or by weavers who weave it into fabrics.

Castor is grown as a field-crop in many parts of India for its seed. Attempts have been made to utilize the leaves in rearing eri-worms but without much success. Only small quantities of cocoons can be reared by individual cultivators. Setting up an organization to collect these cocoons hardly pays. There is demand for cocoons for use in spinning mills in foreign countries, but the price offered for them is such that it does not pay to grow castor and rear the worm. There is another factor. Although a natural silk, eri is much inferior in its qualities to what we commonly call silk and necessarily fetches a lower price.

Eri-rearing and spinning is therefore destined to remain a smallscale cottage industry among poor people unless there is an unexpected rise in its price.

Mulberry Silk-worm

We now come to the other and most important domesticated silkworm which produces what is commonly known as silk and in Bengal as *resham*, *pat* or *garad*. The silk industry in all countries is mainly concerned with the production and manufacture of this silk which is capable of being produced on a large scale, is much more in demand and much more extensively used than any of the foregoing ones. The silk industry in Bengal is chiefly concerned with this silk. Its production and utilization are carried out in three distinct stages and each stage constitutes an important industry.

Production of cocoons is the first stage which forms an ideal subsidiary industry for the cultivator or ryot and is successful only when organized as such a subsidiary industry. The ryot grows a plot of mulberry, the leaves of which form the only food of the worm, rears the worms in his house mostly with the spare-time labour of the members of his family, and sells the cocoons as soon as formed. Production of cocoons in this manner takes about one and a half months and can be carried out four or five times during the year in different seasons. According to climatic conditions cocoons worth about Rs 30 to 40 can be raised from a *bigha* of mulberry calculated at the present low rate of about 8 annas per seer.

Life-History of the Silk-worm

It is the worm which produces the cocoon. With growth it develops a pair of silk glands inside its body and spins out through an opening in the mouth the substance of the silk glands in the form of a filament and builds up the cocoon with this filament as a protection for its own helpless pupa state. After some days when the pupa matures, the moth develops, breaks open the pupa case, and pierces its way out of one end of the cocoon. Male and female moths mate soon after emergence and females lay eggs the same evening. In ordinary temperature eggs hatch in the course of about 8 to 10 days, the worms feed for about three weeks and spin cocoons, and moths develop and emerge in the course of about 10 days more. Worms repeating their life-cycles successively in this manner are called many-brooded or multivoltine or polyvoltine as several broods are obtained during the year. There are other worms which hatch only once in a year in spring and complete a cycle and the eggs then laid hatch again after about ten months in next spring. Such worms are known as one-brooded or univoltine. Bivoltine and trivoltine worms are also known. But the worms which are reared on a large scale are either univoltine or multivoltine. Univoltine worms are suitable for cold countries and are reared in Japan, North China, Kashmir, Italy, France, Spain, Caucasus, and other near eastern countries. Multivoltine worms are reared in South China, Indo-China, Siam, Burma, Assam, Bengal, and Mysore. There are many races among both univoltine and multivoltine worms in the different countries. Generally speaking, the cocoons of univoltine worms are much superior to those of multivoltine worms. A univoltine cocoon contains about 4 to 6 grains of silk and yields a filament length of about 800 to 1000 yards. A Bengal multivoltine cocoon has about 1 to

1½ grains of silk and yields about 150 to 300 yards of filament. The multivoltine cocoons of other countries are practically of the same poor quality or slightly better. Therefore everywhere attempts are made to improve the multivoltine races by crossing them with univoltine ones. It takes several years' breeding and selection to have improved fixed multivoltines capable of being reared by ordinary rearers. Several such improved hybrid multivoltine races obtained in Burma after about 12 years' work were recently introduced into Bengal, where two of these races have been doing well as will appear from the illustration (fig. 1).

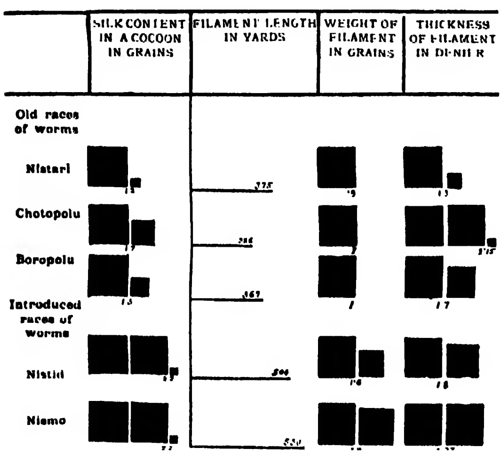


Fig 1.

Qualities of different races of worms.

Qualities of Different Races of Worms

Nistari and *chotopolu* are the two indigenous multivoltines. *Boropolu* is an indigenous degenerate univoltine. *Nistid* and *Nismo* are the two improved introduced multivoltine races. They are capable of further improvement which can be achieved only through continuous hybridization and selection and elimination of undesirable qualities. *In the Bengal climate it is not possible to rear superior univoltine races. Improved multivoltine races are therefore a necessity for the welfare of the industry in the province.*

Disease of Silk-worms

The worms suffer from several diseases and enemies. The worst of the diseases known as pebrine or *kata* in Bengal is hereditary. It swept away the industry in Europe about the middle of the last century. The famous French scientist, Louis Pasteur, investigated this disease and evolved a practical method of eliminating it. The body-juice of the mother moth crushed in a mortar is examined under a high-power microscope. If germs of the disease are traceable in the body of any moth her eggs are rejected. It is necessary for this purpose to isolate every female moth in a tin funnel after she has mated. Elimination of the disease in this manner is necessary for success in rearing. As this is not possible by common rearers, egg production by private persons is prohibited by law in Japan, and all eggs required for rearing are produced under Government supervision and passed after examination by Government agency. In Italy and France too, egg-production is regulated under Government supervision though there is no law against private production for one's own use. In Bengal there is no law. Government nurseries produce eggs according to Pasteur's method, and there are some private egg-producers whose operations are supervised. Many unexamined eggs are reared. Complete control is difficult in the case of multivoltine worms as they can be reared easily by anyone, anywhere and at any time.

Pebrine is also contagious and there are other diseases which are infectious. Therefore it is necessary to look to cleanliness and to disinfect houses and appliances used in rearing. Unsuitable food, such as too tender or too hard and dusty or wet leaves, also cause disease. Even if precautions are taken about sanitation and food, sudden onset of high or cold temperature or heavy rain causes the conditions very uncomfortable and unsuitable for the worms. Although past experience indicates the seasons in which rearing can be carried out, there is always a certain amount of uncertainty in this work. This emphasizes the necessity of adoption of all precautionary measures, which is however difficult

as the majority of the rearers are illiterate and conservative.

Fly Parasite

Apart from diseases the worms are attacked by a parasitic fly which, when it has access to the worm, lays eggs on its body. The fly maggots work their way into and corrode the body tissue, killing the worm usually after it has pupated. The fly maggot then works its way out through a hole in the pupa as well as in the cocoon. Fly blown cocoons become waste. Rearing houses require to be protected with wire gauze and chicks against flies.

Mulberry Cultivation

Mulberry accounts for about 60 per cent of the total cost of cocoon production. In Bengal, mulberry is grown as a field-crop in the form of bush from cuttings. The bushes are pruned down at base four or five times in the year as rearing of worms is done. The field is given necessary cultivation and manuring. In other countries, mulberry is grown from grafts. When grown as trees, which however take several years to be ready, the cost is much less than in the case of bush. Mulberry is usually grown by the rearers themselves and to some extent by others for sale to rearers. In Japan production of seedlings and grafts is a separate industry in the hands of farmers. Everything depends on the provision and supply of leaves. If leaves are available actual rearing does not take more than about three weeks to a month. The quality of the food is very important. Given the best worms but insufficient or bad leaves the result will be poor cocoons. There is scope for improvement in mulberry and its cultivation in Bengal.

Fig. 2.

Cocoonery of straw rope frame. (Japanese).

Rearing House

Rearing of the worms is done indoors. Mud-walled houses with thatch roof are suitable for rearing in Bengal. The trays of worms are arranged in tiers on a temporary shelf erected in a corner of the house. Food has to be supplied about four times during day and night. When full grown, the worms stop feeding and then require to be picked up and placed in spinning trays which have tapes arranged spirally on them. The worms fix and spin the cocoons between the tapes. The cocoons are completed within two to three days when the worm transforms into pupa inside. They are then removed from the spinning tray and disposed of. Two pictures (figs. 3 & 4) illustrating rearing in Japan will be interesting. Absence of the parasitic fly enables rearing to be carried out in the open in that country. For rearing the next

Fig. 3.

Indoor rearing of worms in houses (Japanese).

crop of cocoons, it is necessary to set apart some cocoons which are known as seed cocoons. Moths cut out from them and lay eggs. Usually rearers sell off all their cocoons and procure seed cocoons from other places or preferably from other dis-

Fig. 4.
Outdoor rearing in the open under trees (Japanese).

tricts. Rearing area in Bengal are technically known as *joar* among rearers. Usually exchange is effected of seed of different *joars*. This is a beneficial practice.

Requirements of Cocoon-producing Industry

The requirements of the cocoon-producing industry can now be summarized as follows :—

1. High-yielding races of worms.
2. Availability of healthy, *i.e.*, pebrine free eggs, technically known as seed.
3. Availability of good mulberry leaf in sufficient quantity.
4. Rearing of the worms under clean and healthy condition by experienced rearers, as management and feeding of the delicate worms is an art which though not difficult can be acquired only with practice.

Production and supply of healthy eggs require a proper organization with a trained staff and *is not satisfactory except under State supervision.* This is the first concern of a sericultural department. High-yielding races of worms and good mulberry can be secured only through research and experiment. More than one hundred experts with about five times as many assistants are engaged in Japan in research work on worms and mulberry. We in Bengal are just making a beginning. Two research assistants, one for worms and the other for mulberry, have been just recruited and the Professors of Zoology, Botany and Chemistry of the University College of Science, Calcutta, have been good enough to co-operate in this work. The first researches on mulberry and worms in Japan were carried out by the university professors. It is to be hoped that the co-operation of the university professors with the Sericultural Department, just initiated, will be fruitful of beneficial results for the industry in the province. It is gratifying that private persons are extending help for this purpose. Mr Haridas Mojumdar has given a building and land free of cost at Narayanpur near Dum Dum where research on mulberry will be undertaken.

Sericultural education, provided for in Japan in four universities, three sericultural colleges and 212 schools, will take some time yet to be started in Bengal in a proper manner. At present the Sericultural Department has some arrangement for a preliminary training.

Cocoon Reeling

We now come to the second stage of the industry, *viz.*, utilization of the cocoons by unravelling the filaments from them in the form of thread. The thread is obtained from the middle layers of the cocoon. The outermost and innermost layers yield waste silk which is spun in spinning mills into what is known as spun silk. The cocoons are

boiled in hot water for dissolving the gum which agglutinates the layers of the filament and the filament can then be drawn out in unbroken condition. In practice the filaments of several cocoons are drawn out together and the gum on drying agglutinates them again into a single thread known as raw silk. This art of reeling believed to have been originally invented by a Chinese Princess about thousand years before Christ has now been perfected and is carried out with the help of machinery, but manipulation by human fingers has not been and will probably never be dispensed with. Fig. 5 shows a pedal home-reeling machine used in Japan. The modern practice is first to reel

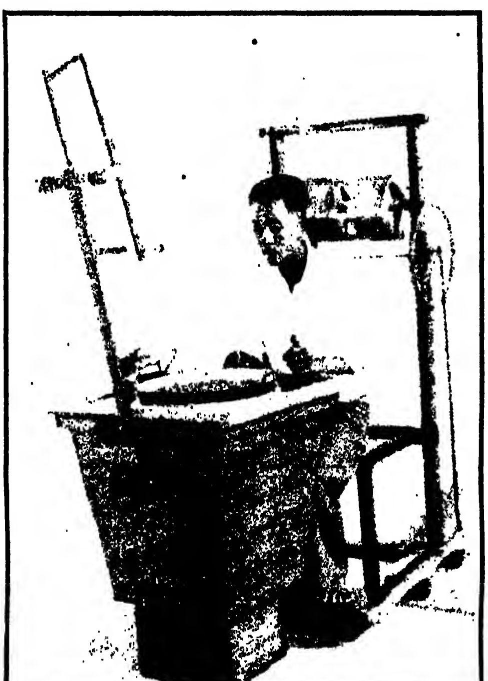


Fig. 5.
Pedal home-reeling machine (Japanese).

the raw silk, then re-reel it, thus eliminating many defects and joining breakages. Re-reeled raw silk is now in demand. After re-reeling the hanks are folded, twisted and dressed and a certain number of hanks are bundled up, pressed and tied into what are called a book. The required number of books to make up 133⅓ lbs. are packed to make a bale. Bales in packed condition are exported The minimum exportable quantity in the trade is ten bales, called a lot.

• Raw silk can be and is woven without further preparation into inferior and cheap fabrics. For production of better class goods it has to be taken through what are class-throwing processes, *i. e.*, rewound, doubled and twisted before it is woven or knitted. Throwing is at present done with up-to-date machinery but Bengal is still following primitive methods. In order that it may work through throwing machinery without trouble and in order that uniform and defectless woven and knitted goods may be produced, the demand is made that raw silk thread should be uniform in thickness, should not break in unwinding and should not have defects, such as slugs, knots, nibs, loops, corkscrews, hairiness, etc., which impede throwing and show in the finished product.

Deniering Meter

Raw silk is therefore nowadays subjected to various tests before acceptance. The most important or major tests are those of (1) evenness to find out how far the contents of a lot are uniform in thickness and (2) cleanliness and neatness to find out how far the thread is free from impurities and defects. Thickness of silk thread is measured by taking a length of 450 meters with 400 turns on a deniering meter and expressing its weight by a French weighing measure called denier equivalent to about 5 centigrams. If, for instance, this denier skein weighs 5 denier the silk is 5 denier thick, and the higher the denier, the thicker the silk. Ordinarily about 11 denier raw silk is the finest thread used.

Testing Machines

Two methods are followed for testing evenness. In Japan, fifty hanks are pulled out at random from a lot and from each hank four denier skeins are taken with the help of a deniering machine doing ten skeins at a time. The weights of the 200 skeins taken separately indicate how far the lot is uniform

and how far it varies in thickness. The other method is rather ingenious and carried out with the help of a machine called seriplane. This machine winds the thread neatly and side by side in regular order on a revolving black board. The practice is to wind a sample for a width of five inches called a panel on the board and a board accommodates ten such panels. Two panels are prepared from each of the 50 hanks or a total of 100 panels on ten seriplane boards. The panels are then examined and compared with officially prepared photographs of standard panels which have been assigned marks according to uniformity or extent of disuniformity. This visual examination is done in a specially prepared room with special arrangment for lighting. The raw silk under test is given marks according to its approximation to the standard photographs. To determine cleanness, defects, such as slugs, etc., are counted on the panels and are given marks according to the number present. Neatness is rated by comparison with standard photographs.

Winding Machine

Other tests are carried out to find out the following, *viz.*

(a) Breaks in unwinding; the fifty test hanks are unwound on a winding machine for 1 hour 10 minutes and the number of breakages noted in the last one hour.

(b) Deviation or variation in the thickness of the thread in the lot.

(c) Average thickness of the thread calculated from the deniers of the 200 denier skeins.

(d) Tenacity or strength of the thread and its elongation or elasticity and stretch before breaking; this used to be tested on serimeter but nowadays serigraph has been adopted for the purpose.

(e) Cohesion of the component filaments of the thread; the thread is rubbed in a cohesion machine and the number of strokes necessary to separate and open the filaments is noted.

Boiling-off test by boiling a known weight in soap solution and determining the proportion of natural gum in the thread is also carried out but not required in the quality tests described above. Hardness, softness, colour and lustre of the thread are determined by feeling with fingers and ocular examination in a darkened room with north light.

Necessity of International System of Grading

As a result of all these tests the raw silk is placed in one or other of different grades at present recognized in different countries. Several attempts have been made and conferences held to arrive at an international system of grading or classification of raw silk. The systems now approximate so closely that an international one is soon expected. Grading is essential where raw silk is a commodity dealt with in the future market in an exchange as in Japan, America, and Italy. Japan and China have arranged for exporting raw silk with a certificate of quality on the result of the quality tests detailed above.

Raw silk is hygroscopic and increases or decreases in weight with the increase of moisture in the atmosphere. In order that neither buyers or sellers may incur any loss on account of this fluctuation in weight, buying and selling is done on conditioned weight. A few hanks in a lot, usually eight, are dried thoroughly in a conditioning oven and the absolute dry weight noted. The conditioned weight is the absolute dry weight plus 11 per cent of the same.

Conditioning Ovens in Yokohama Conditioning House

The market demands a guaranteed supply of a standard quality of raw silk. In order to meet this demand Japan was wise enough to establish a Government Conditioning House at the Commencement of her raw silk trade. The Conditioning House examines each bale to see that no fraud is perpetrated, determines conditioned weight, carries out the various tests, issues certificates as to conditioned weight and quality, and seals the bale. The Custom authorities do not allow any bale to be exported if the seal is suspected to have been tampered with. Conditioning Houses also exist in the United States of America, England, France and

Italy. Japan maintains conditioning houses in villages for raw silk used by silk weavers.

Reeling Industry in Bengal

Bengal had a large reeling industry till about fifteen years ago. But it was carried on all along with the simple machine adopted at the time of the East India Company. There was no re-reeling and no conditioning house. The supply of raw silk was never guaranteed to be up to any standard and there were many loopholes for fraud to be perpetrated on the buyers. The market was thus lost although Bengal silk was the first to become famous in the world. The large reeling concerns were closed. This was followed by contraction of the rearing industry as cocoon-producers found no sale for their cocoons. The rearing industry disappeared from Bogra and Rajshahi districts and contracted in other districts. At present reeling is in a disorganized state and carried on practically wholly by small concerns or individual reelers who do not understand what standardization means. During the same period Japan made tremendous progress. This she was able to do on the strength of the research and experiment she arranged for every aspect of the industry and through adoption of up-to-date machinery and methods. As each reeler produces about half a pound of raw silk in a day in order to be able to produce large quantities of a uniform raw silk it is necessary to engage a number of reelers at one place and make them work under supervision with simultaneous tests to see that they are working properly. Reeling is therefore essentially a capitalistic industry. It is necessary to arrange for machinery, to engage reelers, and to buy raw materials, *viz.*, cocoons for cash. The industry however can be carried on either on a small scale by engaging four, six, eight or ten reelers or on a large scale with 50, 100 or several hundred reelers. For a small eight-basin concern a capital of about Rs 2,500 is required. Of this amount about a thousand will be for machinery and appliances and the balance as working capital which will revolve four or five times during the year and fetch on efficient working an income of about Rs 600 at the present low price of silk.

Peddie Reeling School at Maldah

A small reeling school known as Peddie Reeling Institute has been started this year at Malda with simple improved machinery of cottage type. Improved reeling methods can be learnt here. With improved cocoons now available as explained above, reeling offers an opening to middle-class young men. The work is also suitable for women's organizations as it affords easy indoor work for women. The most suitable method is to have these reeling concerns among groups of rearers and work in co-operation with them. Large reeling concerns in Japan supply eggs of improved races of worms to rearers and cocoons are paid for according to their quality and yield of raw silk. This is the only condition under which both rearing and reeling flourish.

The reeling industry in Bengal has to be built up anew. A conditioning house is essential which will on the one hand study demands of raw silk and on the other hand guide the reeling concerns both existing and new.

Silk Knitting and Weaving

We now come to the third stage of the industry, *viz.*, knitting and weaving of raw silk into fabrics. Time will not permit me to go into details. I shall only indicate the lines on which progress is necessary The cocoon-producing and reeling industries, together known as raw silk industry, supply the raw material for the manufacturing industry and flourish only when they produce the material in every way suitable for the latter. Because Japan fulfilled this condition, her raw silk is welcome everywhere. While silk manufacture can be carried out anywhere production of the raw material is limited to only a few countries of which Bengal is one. There is demand for raw silk in many countries and it is only necessary to produce it according to the desired standard. There is a scope of large production of raw silk in Bengal and such production need not be regulated by the extent of silk weaving in the province. Expansion of weaving however gives a

stimulus to the raw silk industry on account of greater use of raw silk.

As is well known, Bengal had extensive silk weaving. But this industry languished for want of proper research, experiment and organization. Cloths require standardization. Enquiries at the stores of Sindhi merchants in different foreign countries in the course of my travels as to why they did not stock and sell silk fabrics manufactured in India invariably elicited the reply that no two pieces produced in India were alike in quality or size and such unstandardized products had no market. The reason why Japan has been so successful is that her Government, through consular staff and special investigators sent out by the commerce and industries department and associations of manufacturers through their own special agents sent out for the purpose, study markets and produce standardized goods according to the demand. For production of standardized goods weavers have been combined into associations and there is a law to force all to join such association when two-thirds of them in a place agree. Goods are produced according to specifications, are collected and examined by the association, are washed and finished at a central place and are then sent to Government cloth examining houses where each piece is examined and is either stamped as passed or rejected. Without pass stamp the custom authorities do not allow any piece to be exported. It is necessary to follow the same lines here.

In Bengal there are excellent silk weavers but for want of proper organization goods according to any standard specification cannot be got made in any quantity. Unless production and supply in a definite time in large quantities and according to specification can be guaranteed no market can be secured. If these conditions can be fulfilled there is a large scope for the silk-weaving industry.

At present most of the silk weavers are in the grip of mahajans who are mere traders and only understand rupees, annas and pies. The weavers must be freed from this predicament and formed into associations which will deal directly with the market. It is also necessary to improve processes to produce new designs, to improve dyeing and printing and to arrange for proper finishing. These are matters which fall within the scope of an efficient up-to-date silk technological institute. Last of all there should be sufficient propaganda and a good marketing organization.

Requisites for Revival of Industry—Beneficent State Legislation

I hope I have been able to convey now an idea of the nature of the silk industry. The first stage or cocoon production is an ideal rural industry suitable for poor cultivators to whom the sale proceeds of cocoons in four or five different seasons in the year are very welcome and helpful. This is why sericulture flourishes in countries with a poor peasantry. Reeling, though capitalistic, is also a rural industry, giving employment to the rural population. From its nature the industry cannot flourish without State help and because of the fact that it helps the rural population in some countries apart from organization of research, education and propaganda, the State pays bonuses on production of cocoons and on the number of basins worked for reeling. The industry also requires protection. The silk-weaving industry of England dwindled in the last century when protection was removed and was immediately followed by the rise of an industry on the continent with English capital and English skilled labour. The United States of America has been able to build such an extensive manufacturing industry as to consume the major portion of Japan and China's exportable raw silk only under the protection of a high tariff-wall. Japan maintains a prohibitive tariff against import of manufactured silk. The silk-weaving industry in India too similarly requires sufficient protection. As raw silk is produced in three large areas in India, *viz.*, Bengal, Mysore and Kashmir, the raw silk industry also requires protection. If there had been this protection, the industry would not have suffered in the recent economic depression as much as it did, although much of it was more or less due to an accident. Owing to financial depression the United States of America stopped taking its usual supply of raw silk from Japan, where Government came to the assistance of

the reelers and purchased and stocked the raw silk with the hope of being able to sell it at a future date. This sale was soon after effected at about a third of the price paid for the raw silk to an American financier and this led to dumping in India at abnormally low and wholly uneconomic prices. The reeling industry in Bengal already disorganized suffered heavily. Many reelers stopped work and necessarily many rearers of silkworms also had to stop work as they could not sell their cocoons. The Government imposed a protective tariff which was however not quite sufficient and not at the rate recommended by the Tariff Board and which was further nullified by smuggling through the French possessions in India and even through other probably less guarded ports, such as Karachi. It is only now that the industry has begun to look up again apparently because the old cheap stock is exhausted and imported raw silk is selling at a price with which the Indian product can compete. There should be a permanent tariff in order to ensure that no imported raw silk may sell at less than Rs 6 per lb. The tariff on all imported silk fabrics should also be based on this price for raw silk.

Subsidiary Industries

Any description of the silk industry will not be complete without a reference to its by-industry in the form of production of the well known *Matka* cloth which is a speciality of Bengal. We have noted that seed cocoons have to be set apart for breeding purposes. The cocoons after the moths cut out cannot be reeled but are spun with the same useful *Taku* by women folk of poor families in their spare time in the midst of household work for a small remuneration. This thread is known as *matka* which is woven into *saris*, *dhotis*, *chadars* and then for shirting and suiting purposes. A recent census shows about 12000 'matka' spinners and about a thousand looms engaged in matka weaving in different districts in Bengal. Matka spinning is done nowhere else in India. The matka industry is dependent entirely on the cocoon-rearing industry. With the contraction of the cocoon-rearing industry it has been necessary to import pierced cocoons from Mysore and Kashmir. Pierced tasar cocoons are similarly spun into what is called *kete* which is woven into similar but less appealing fabrics as with matka.

Rayon or Artificial Silk no Rival to Natural Silk

I shall close with a few words about rayon, formerly known as artificial silk but now prevented by law from being described as silk in several countries. Rayon is a vegetable fibric made out of wood, mostly pine wood, dissolved by chemicals and drawn out as thread. It took people by storm on account of highly glossy silky appearance though really lacking in the properties for which the natural silk is prized, *viz.*, texture, strength, durability and washability. Fig. 6 shows how it compares with silk in these properties. It is only one fourth as

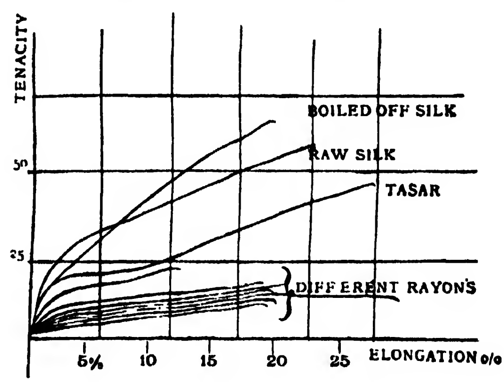


Fig. 6
Comparison of rayon and silk.

strong as the natural silk fibre, can hardly stand washing and does not possess the purity with which the Hindu invests the *patta-bastra.* Rayon however is useful for many purposes and its production has increased by leaps and bounds in Japan, Europe, and America. On account of its cheap price it is competing more with cotton than with silk and will do so more in future. That it has taken the place of silk to a certain extent and especially among people ignorant of its real nature cannot be gainsaid. But silk has regained its place to a great extent and will hold its own.*

* Based on a lecture delivered in the Indian Association for the Cultivation of Science.

Fruit Preservation–Its future Possibilities in India

S. M. Sircar

Storage of fruits by modern scientific methods for consumption throughout the year is an achievement that is almost unknown in India except a recent press message from Simla (June, 12, 1937), in which it is mentioned that the Government of India is engaged in taking steps to help the apple- and grape-growers of Kashmir and Baluchistan with useful information for fruit culture and storage. In England, under the auspices of the Food Investigation Board and the research stations at the Cambridge University and at the Imperial College of Science, London, considerable investigations have been made in the preservation of fruits with very remunerative results. It has been possible to store apples in a fresh condition for a period of one year without any deterioration or harmful effect; thousands of tons of easily perishable fruits like pears are successfully shipped in bulk to Great Britain from South Africa, California, and Australia. This success could not be achieved if elaborate scientific techniques had not been evolved and standardized as a result of a long period of experiments and observations.

India produces some of the best varieties of fruits in the world. The notable amongst them are mangoes, oranges, bananas, lichis, apart from some other citrus fruits such as lemons, grapefruits, etc. It is time to consider how many millions of these valuable and nourishing fruits are absolutely wasted in India due to the overcrowding of harvest within the range of a very short period. If even a fraction of this rich harvest of fruits could be preserved by modern scientific storage methods, the growers and the consumers would be equally benefited by the result throughout the year both in India and abroad, specially in England which is decidedly the greatest market for fruits in the world. The mango is a fruit almost unknown in England. Owing to the fact that this fruit deteriorates very easily and quickly, it has not been possible to send the best specimens of Indian mangoes to England. Mangoes grown in the West Indies and some parts of South Africa have been imported to England, but the fruit has not been received with much favour owing to the lack of the unique taste and aroma that is to be found in the Indian varieties. Whereas the price has been prohibitive in some instances owing to the excessive cost of sending by air, the Indian mango has generally been received with much favour and enthusiasm. Enquiries made about the market of oranges and mangoes in England from the leading wholesale fruit merchants at the Covent Gardens, London, and also from the leading retail dealers spread over the city have given me the impression that there is a stupendous possibility for these fruits in England if only they can be sent here in proper condition. Needless to say that the same applies to our own home market when fruits are out of season.

It is admitted by many Englishmen that the Indian banana is decidedly superior in aroma and taste to the Jamaica varieties which are sent to England in millions by Messrs Elders and Fyffes Ltd., who monopolize the market. It is the considered opinion that the "Indian banana possesses a bouquet all its own and would, it is believed, become popular at once with European consumers. The variety *Champa* grown in the neighbourhood of Calcutta is decidedly the finest of all, rivalling in lusciousness and delicacy the most delicious pear. The Indian banana grows abundantly, and the supply could be made practically unlimited. All that the Indian needs to learn is how to cut

the bunches at the right time, to handle the fruit without bruising, so that it can be landed in 25 days on the English market before it begins to get yellow. The only thing lacking, it is claimed, is quickness of transportation, but this may be soon forthcoming. The fruit is in plenty in India and the surplus needs a market, and if enough money is raised to back the enterprise, it is believed that India can get her share of the banana trade of Europe and hold it"[1]. The same thing applies to the oranges grown in India which are undoubtedly better than those marketed in Europe.

Important Factors in Fruit-Preservation

Now some of the factors in the preservation of fruits for a reasonable length of time will be dealt with in the following paragraphs.

Pre-storage condition : There are some factors which are of essential count with fruits intended to be grown for storage. To produce the best keeping qualities in most varieties of fruits the minimum quantity of nitrogenous fertilizers that will produce adequate growth should be applied to the soil together with plenty of potash and phosphate. It is also necessary to take great care to produce clean fruits free from scab, insect-punctures, etc. The orchard must be kept clean of decaying fruits on which spores of fruit-rotting moulds are easily produced.

A great point often overlooked in our country when plucking the fruits is that the fruits are rather roughly handled and greatly injured by throwing them on the ground. Strigs should not be pulled from the fruits and every fruit should be placed gently in the orchard boxes rather than rolled from the baskets, and during transport to the stores every care should be taken to avoid shaking and rubbing. All fruits showing any form of mechanical damage should be rejected. It is also advisable to grade the fruits for size before they are placed in a storage.

1. W. Fawcett : *The Banana* (1921), p 184

Time for gathering : There is unfortunately no essential criterion to guide the grower to the best time to pluck the fruits. But utmost care should be taken that the fruits are neither too green nor too ripe at the time of plucking. Although the green types keep the longest, yet they lack in the essential aroma of the fruits for which their market value may be immensely diminished. By experience one can easily ascertain the optimum time for gathering the fruits.

Oiled wrappers : For long-period storage of fruits the practice of wrapping the fruit with oiled tissue paper has been found to be very beneficial. Oiled wrappers not only control superficial browning, but in some way tend to preserve the fresh appearance of the fruit. It has been suggested that the use of this type of wrapper would affect the gas exchange of the fruit by acting as a barrier to the movement of carbon dioxide and water vapour. The ordinary wrappers do not appreciably affect the rate of exchange of air and carbon dioxide between the fruit and the atmosphere around it. In many gas storages, wrapping with oiled papers has been found to be essential to preserve the appearance of the fruits which count a good deal to the consumer. The onset of rotting in certain fruits is found to be greatly retarded by the use of wrappers treated with a solution of iodine in potassium iodide.

Storage Condition

It forms the integral part of fruit preservation. The methods that have been developed for the successful storage are (1) cold storage, (2) gas storage, and (3) refrigerated gas-storage. The last of these is essentially a combination of the first two in which a control of temperature is found necessary since the object of storage in retarding further the ripening process is greatly facilitated.

Cold storage : The principles underlying the cold storage are that at low temperature physiological processes leading to the ripening and deterioration of fruits are much retarded. In order to suppress temporarily, all such activities responsible for deterioration and ripening, temperatures near about

freezing point are recommended for storage. To find an optimum temperature for a particular fruit, experimental investigations are necessary. It has been shown by detailed research that the difference of only 1°F in the average temperature during storage may make a significant difference in the storage life of the fruit. The particular temperature to be employed varies according to the nature of the fruit. The condition of the fruit is also an important factor for the storage temperature ; in cases where unripe fruits are used higher temperatures are found to suit the storage condition better; when more mature fruits are stored, *i. e.*, fruits exhibiting the signs of softening and colouring, the lower temperature is the best. In cold storage of English plums the temperatures employed under two conditions of the fruit are 40°F and 31°F respectively. A great deal of success in the preservation of fruits like strawberries, blackberries, loganberries, etc.. has been achieved by freezing at a temperature below zero point. In this case the fruits are frozen solid and then at the time of consumption, thawing is gradually made to take place at a controlled low temperature. The difficulties encountered in the methods of freezing and cold storage are considerable physical and chemical changes, both at the time of freezing and thawing, which impoverish the fruits in respect of colour, flavour, palatability, digestibility, and of nutrition. To avoid these, freezing with syrup or quick freezing at a temperature between 0°F and -10°F and slow thawing over a period of 24 hours at 31°F to 40°F are recommended. In cases where fruits are stored at low temperature without freezing, similar damage due to functional breakdown and disorganization of the fruit is noticed. For all kinds of fruits there exists a low temperature limit of tolerance. When kept below this temperature for any length of time, various types of low temperature injury are induced in the fruit resulting in serious damage and loss. So for different kinds of fruits the optimum temperature to be maintained is a point of great consideration in the methods of cold storage. In the case of Indian fruits for cold storage scientific investigations are to be undertaken to determine the temperature at which a particular fruit could be stored without showing any sign of low temperature breakdown, either during storage life or during marketing.

Refrigerated Gas Storage

In this method the principal features are the control of the composition of the atmosphere and of the temperature. The rate of respiration determines the rate of ripening, which can be retarded not only by lowering the temperature as mentioned in the methods of cold storage but also by reducing the oxygen content of the air and by increasing the carbon-dioxide content. Fruits respire like all animals by giving off carbon dioxide in exchange of an equal volume of oxygen. The atmosphere of any fruit store will therefore always tend to increase the percentages of carbon dioxide and decrease that of oxygen from normal air. In an atmosphere containing more carbon dioxide and less oxygen than normal air, the respiration of the fruit is greatly reduced and the process of ripening is also retarded. Air consists of oxygen and nitrogen in the proportion of 21 : 79. For the composition of the storage atmosphere it is the oxygen concentration that is reduced and a certain percentage of carbon dioxide is retained from the respired fruits. The method generally adopted for this is to absorb the excess of carbon dioxide respired by an absorbent like sodium hydroxide, oxygen being replaced by a regulated ventilation with fresh air in a gas-tight chamber. To determine the composition of the atmosphere is a difficult process and at this stage systematic works with different kinds of fruits are to be accomplished before any enterprise of commerical fruit-storge is taken in India. It is to be mentioned that if an unsuitable atmosphere and temperature be employed it may bring about a severe loss in the industry. Apples stored at a faulty atmosphere in a cargo boat have shown harmful effects at the end of five weeks' storage during transportation to England. The experiments conducted by the Food Investigation Board in England with various kinds of apples have shown the remarkable difference in behaviour of different varieties in the various atmospheres, and

clearly indicate that controlled investigations purporting to obtain the best combination of temperature and atmosphere for each variety must be performed before gas storage is put into commercial practice. It is a wellknown fact that the different varieties of mangoes like *Langra*, *Fazli*, *Bombay*, *Gopalbhog*, etc., and of oranges from Darjeeling, Nagpur, and Sylhet have different times of maturity and ripening and require different environmental conditons. In view of this, it is apparent that the storage conditions of these different varieties of fruits will vary according to the nature of the fruit. The results of the experiments performed in England for successful gas storage of different varieties of apples may be quoted here (table 1) from the *Food Investigation Board Report*, 1934. This will give an idea of the difference in the composition of the storage atmosphere and temperature.

TABLE I

Temperatures and atmospheres recommended for the storage of English apples (F.I.B.R. 1934).

Variety	Temperatures of flesh of apple	Percentage of Carbon dioxide	Percentage of Oxygen
Culinary varieties			
Annie Elizabeth	34 to 35	0	21 (air)
Bramley's seedling	40	8 to 10	13 to 11
King Edward VII	37 to 40	5 to 10	2.5
Lane Prince Albert	39 to 40	5	2.5 to 5
Lord Derby	40	8 to 10	13 to 11
Monarch	34	5	2.5 to 5
Newton Wonder 34	34	0	21 (air)
Stirling Castle	40	8 to 10	13 to 11
Dessert varieties			
Blenheim Orange	37 to 38	0	21 (air)
Cox's Orange Pippin	39 to 40	5	2.5
Ellison's Orange	34	5	2.5 to 5
King's Pippin	39 to 40	0	21 (air)
Laxton's Superb	40	10	2.5
Worchester Pearmin	34 to 35	5	2.5 to 5

Some varieties of apples require a very low proportion of both the gases. In these cases cold storage is preferable to gas storage since in the latter it is difficult to obtain correctly a very low concentration of the gases by regulated ventilation.

For many varieties of fruits the refrigerated gas-storage has the following advantages over the cold storage because of certain percentage of carbon dioxide in the atmosphere.

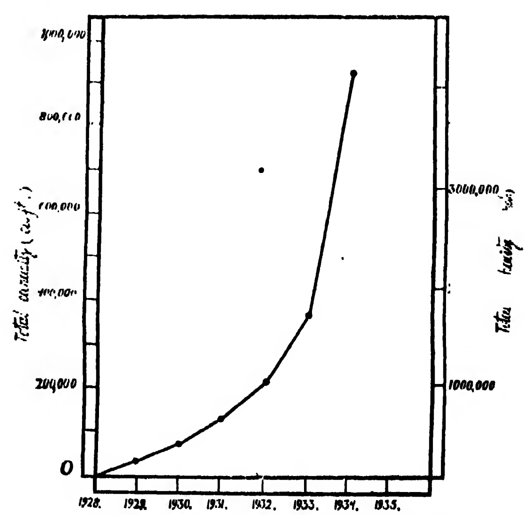
(*i*) The ripening of the fruit is slowed down considerably, thereby increasing the life of the fruit in the storage condition.

(*ii*) The delaying of the beginning of the *climacteric* change. By *climacteric* change is meant the critical change of the state of fruit which precedes the ripening, softening, odour and flavour development.

(*iii*) The hardness of the fruit is preserved almost unchanged.

(*iv*) The life of the fruit after removal from the store is greatly prolonged, which is a distinct gain to the distributor and the consumer.

The development of the gas storage for fruits in England has increased considerably since its installation in 1928 as the accompanying figure shows. The number of concerns dealing with commercial



Capacity of commercial gas-stores for fruit in England.

gas stores in England has increased from 12 in 1928 when the industry was first developed to 80 in 1935.

FRUIT PRESERVATION—ITS FUTURE POSSIBILITIES IN INDIA

Need of Research on Indian Fruits

It is not surprising that commercial gas-storage of fruits, specially apples, has been very rapidly taken by growers in England with a considerable gain. *The success of the industry can be attributed mainly to the fact that commercial application of gas storage of apples, etc., has invariably been preceded by long laboratory experiments and storage trials on a semi-commercial scale and the people interested in the industry were instructed for the application of the results on a commercial basis.* The present knowledge of the subject is quite inadequate to enable the investigators to say precisely what are the most favourable conditions as regards temperature, concentration of carbon dioxide and oxygen for fruits which have not been scientifically tested.

If the wide possibilities of gas storage for fruits, such as mangoes, oranges, bananas, etc., are to be opened up, two things are essential. Research on the fundamental physiological problems should be encouraged. These will include the carbohydrate and nitrogen metabolism of fruits during storage, the preservation of the vitamin content, resistance to fungal invasion and resistance in relation to the chemical composition of fruits. These investigations involving the expenditure of time and money should draw the attention of the corporate scientific institutions where all these aspects could be worked out by experts. Unfortunately in India no such institutions are in existence. In a forthcoming article the writer from his knowledge of experiments done with fruits in England hopes to give an outline of the possibilities of chemical changes of fruits that may take place during storage life. Pending the solution of these problems, storage trials under scientifically controlled conditions should be carried out, before embarking on adventures on a commercial scale. The object of such trials should be to define the requirements of the fruit in view, accordingly the range must necessarily be wide in order to cover a reasonable number of combinations of atmospherical, thermal and pre-storage factors as mentioned before. The cost of the necessary material and equipment for carrying out investigations of this kind is necessarily heavy. Nevertheless it is preferable to finance scientific investigations rather than to obtain knowledge by the method of trial and error on a commercial scale which not only involves the trade in a series of catastrophes but inevitably leads to a loss of confidence on the part of the grower, the distributor, and the consumer.

The Cold Storage of Apples

The following notes on the behaviour of different varieties of apples in cold storage should prove helpful to growers:—

Delicious—If picked when well coloured and placed in store straight from the tree this variety will hold well till October or November. The flavour improves during storage.

Democrat—This variety is a splendid storer, keeping well till the last, except in the case of over-sized fruit, which goes "sleepy."

Yates—This apple is an excellent storer and will keep to the last if the fruit is promptly stored.

Rome Beauty Stores satisfactorily when well coloured, but large fruit of this variety should not be held too long.

Rokewood and Crofton Both these apples store very well.

Stayman Winesap - Goes "sleepy" if held too long and consequently should be cleared up by the end of July.

Granny Smith- This variety stores very well if precautions are taken to guard against scald.

—*The Agr. Gazette*, May, 1937

The Mystery of Cosmic Radiation—Part III

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Origin of Cosmic Rays

We have at present some knowledge, though incomplete, of the nature of cosmic radiation, but an almost complete mystery envelops the question of of the origin or source of this radiation. Various hypotheses have been put forward from time to time, two of which due to Jeans and Eddington have been already mentioned in the preceding paragraphs. These two may be definitely ruled out as unlikely, for we now have convincing evidence in favour of the corpuscular nature of cosmic rays. Another hypothesis, which was for some time advocated by certain workers, was based on the idea of "runaway" electrons due to C.T.R. Wilson (1921). According to Wilson's suggestion, electrified particles in the earth's atmosphere could be accelerated to very high velocities by the electric field of the atmosphere in thunderstorms and could pick up practically the whole energy of potential drop (about 10^9 volts). These "run-away" particles would produce the same effect as that produced by cosmic rays. A certain amount of direct evidence against this hypothesis was, a few years ago, brought forward by the observations of Schonland (1930), who found that in South Africa overhead thunderclouds with an excess of positive charge gave rise to a reduction of the order of 40 per cent in the intensity of the penetrating radiation, indicating that the primary corpuscles consisted mainly of positively charged particles ; but he found no evidence for the existence of beams of "run-away" electrons below these clouds. The observations on cosmic rays at high altitudes (far above the levels at which thunderclouds occur) which we have mentioned earlier in these articles also definitely contradict the above hypothesis which postulates a terrestrial origin of the penetrating radiation, Moreover it is quite impossible to reconcile the idea of "run-away" electrons with the observed latitude effect. As a matter of fact there is absolutely no doubt at present that the primary cosmic rays are of extra-terrestrial origin, but whether the source is in the depths of cold interstellar space or the hot interior of stars is a problem that yet awaits solution.

Cosmic Rays and the Astronomical Universe

An hypothesis put forward by Nernst as early as 1921, according to which the stars were to be regarded as the source of cosmic radiation, held the field for a long time, and still enjoys a considerable amount of popularity among the experimental workers on cosmic rays. In the vast literature on this subject one finds experimental evidence both in favour of and against this hypothesis. Kolhörster, v. Salis, Büttner, Hess and others believed that their observations indicated the existence of a variation of cosmic-ray intensity according to sidereal time, while Millikan, Hoffmann, Steinke, ands other could detect no such sidereal period. Kolhörster found that the intensity was greatest in the plane of the Milky Way, so that the rays were to be supposed to originate in the stars, the gaseous nebulae and diffuse matter in our galaxy. On the other hand, the later and perhaps more accurate measurements of Millikan and Cameron showed no directional effect in cosmic rays at all, which is at variance with results reported by Kolhörster. The impression therefore got abroad that *cosmic rays are isotropic, that is, they come with equal intensity from all directions in space.* If this impression be based on truth the source must be symmetrically distributed round the earth and therefore, as Eddington has said, we have to consider the closed spherical universe of the theory of relativity, which alone can provide the necessary symmetry. It may be noted here however that quite recently A. H.

Compton pointed out that even if the sources of cosmic rays are symmetrically distributed over the Einsteinian universe (and outside our galactic system) the rays as observed on the earth ought not to be strictly isotropic. We belong to the galaxy (on the Milky Way) which according to modern investigations (Shapley, Oort, Lindblad) is revolving about a point in the Sagittarius region. Our sun is almost ⅔ of the radius from the centre of the galaxy to its rim, so that the sun is moving with a velocity of 300 km./ sec. towards a point in the Hercules Region (47°N, R. A. 20^h 55^m). This translatory motion of our galaxy should, according to Compton's theory, cause an increase of about 0. 1 per cent in the intensity of cosmic rays on the side of the earth facing the direction of the galactic motion. Compton considers that existing observations show that this translational effect actually exists. But it is extremely difficult to attain this order of accuracy in cosmic-ray measurements, for the intensity as measured in the lower levels of the earth's atmosphere has to be corrected for a number of atmospheric influences, such as the barometer-effect, the temperature-effect, etc.—a procedure full of uncertainties. Hess very recently (Dec. 1936) expressed the view that existing observations of intensity when properly corrected for barometer and temperature effects show no transitional effect, as deduced by Compton. Thus the existence of the translational effect has not yet been experimentally established, but the theoretical possibility of its existence remains; so that a strict isotropy of the cosmic rays is not to be expected even if they are, as seems very probable, phenomena of the Einstein Universe.

Cosmic Rays in the Expanding Universe

It is well known now from the theories of Friedmann, Lemaître and Eddington and the observations of Hubble on the recession of nebulae that the Einstein Universe is expanding at the rate of about 550 km./sec./megaparsec; that is to say, a nebula at 1 megaparsec (=3.26 million light-years) distance should have a speed of recession 550 km/sec., at 10 megaparsecs distance 5500 km./sec., and so on. Eddington estimates that the universe has expanded about five-fold since it started expanding from its initial state in which cosmic repulsion just balanced gravitational attraction. According to a view once expressed by Lemaître and Eddington, cosmic rays were produced by some yet unidentified sub-atomic process which took place when the universe was close to its initial state; if this sub-atomic process is identified, we shall be able to "tell just how much the universe has expanded since then", for "cosmic radiation is a collection of relics stamped with an inscription indicating the dimensions of the world in its earliest stages". But Eddington warns us against the mistake of identifying the wave-lengths of cosmic rays (as deduced, by the application of the Klein-Nishina formula, from the present measures of absorption co-efficients) with the initial wave-lengths, for the rays must have softened by a factor of 5 or more since they first came into existence. Experimental physicists will regard this speculation as one more fairy tale of astronomy, —and perhaps with sufficient justification, for it has been definitely disproved that cosmic rays, as observed on the earth, possess unmistakable characteristics usually attributed to photons. On the other hand the latitude-effect unmistakably points to the corpuscular nature of cosmic rays.

Milne's Theory of the Origin of Cosmic Rays

A very recent hypothesis due to Milne (1935) seems to fare better in this respect, for he identified "the primary agency responsible for cosmic rays with high-speed particles accelerated to the vicinity of the speed of light by the gravitational pull of the rest of the universe". Milne claims that "it can be shewn from the properties of his kinematic world models that any unimpeded (*i.e.*, freely moving) particle, at large in intergalactic space, undergoes acceleration as reckoned by an observer located on any arbitrary nebula, and attains the speed of light at some finite epoch in the experience of that observer. It then decelerates. It can also be shewn that at any arbitrary epoch, in any arbitrary domain of intergalactic space, there will occur some particles possessing velocities arbitrarily close to that of light. If such a particle, of atomic dimen-

sions, happens to undergo collision during this phase of its trajectory, it will give rise to effects similar to those observed in cosmic-ray experiments".

At present there appears to be no experimental evidence that can be regarded as fatal to Milne's hypothesis, but there are a number of considerations which point to the conclusion that cosmic rays need not necessarily originate from the mechanism contemplated by Milne. Towards the end of 1934 Kolhörster and Jánossy have shewn by very accurate measurement that cosmic rays are far from being isotropic, thus justifying the earlier results of Kolhörster, Büttner, Corlin and others. In former years when the experimental technique had not developed so much as at present all observers were agreed that the sun could be ruled out as a possible source of cosmic rays. But in recent years, with the use of high-pressure ionization chamber, Hoffmann, Lindholm, Hess, Compton, and others have arrived at the conclusion that there is a definite, though extremely small, difference between the average intensities of cosmic rays during the day and the night, the day intensity being about 0.7 per cent more than the night intensity, and the absorption co-efficient of the difference in ionization being about the same as that of the whole of the cosmic radiation. Hess and Steinmaurer (1933), Freytag (1933), and Corlin (1931) have also detected certain connections between the intensity of cosmic rays and sunspots, magnetic storms, auroral displays and similar phenomena which are recognized to be of direct or indirect solar origin. Thus there has been a tendency to conclude that the sun is responsible for an extremely small fraction of the observed cosmic rays. Now if the sun, which is but a comparatively old yellow dwarf star, can emit cosmic rays, then the other stars, for example, the young giants and more especially the novae, should be expected to be far more potent sources of cosmic radiation. Of course, on account of great distance, their effect would be proportionately diminished, and hence the view that cosmic rays are isotropic in space remain unaffected. If there is any truth in these observations, there is a certain amount of probability in the empirical relation claimed to have been observed by Kolhörster and others that the maximum in the intensity of cosmic rays occurs when the Milky Way crosses the Zenith, that is, when the greatest depth of the stellar system to which we belong is overhead. If this relation of the intensity of the penetrating radiation to the position of the Milky Way be true, then it may turn out that it is unnecessary to consider sources outside our own galactic system. In any case, whether the sources belong to our galaxy or to the extragalactic systems, the important ones are most likely to be the bright and dark nebulae, the ordinary interstellar matter and the outer layers of the stars and possibly of the sun; for the hot interiors of ordinary stars lie behind screens of stopping power much greater than a metre of lead* so that all the penetrating radiation from stellar interiors would be softened beyond recognition by Compton scattering. The position is however very different in the case of the novae or new stars in which matter from the interior rushes out with tremendous velocities sometimes of the order of 2000 km/sec., as is evidenced by the displacement of the lines in their spectra. It would be outside the scope of the present article to discuss the possible causes and theories of nova outbursts, but we shall indicate in another article how nova outbursts can give rise to fast-moving particles which may be identified with the cosmic rays as observed on the earth; indeed the view has been advanced that the whole of the cosmic radiation may have its origin in nova outbursts.

* The stopping power of the whole of the earth's atmosphere is roughly equivalent to 10 metres of water or ice or 1 metre of lead.

Drilling Mud: Its Manufacture and Testing*

The Mining and Geological Institute of India has recently published (Dec. 1936) in their *Transactions* account of a very interesting series of work done by Messrs P. Evans and A. Reid. It is well known that the Burmah Oil Co. has been the pioneer in Burma and India in the development of the oil industry. They have carried out a large number of experimental borings in search of oil in Burma and Assam, using the latest appliances, and often using inventions of their own. Their scientific workers have, in this way, not only increased our knowledge of the Earth's crust, but have sometimes presented science with phenomena of a new type. The new phenomenon deals with the borderland between the liquid and the solid state, and the following is a short story of its discovery.

There are three drilling systems in regular use in the oil industry: percussion or cable-tool drilling, core drilling, and rotary drilling. The rotary drill, of comparatively modern development, is by far the most important, and has enabled the prospector to reach depths of ten and even twelve thousand feet in his search for new supplies of oil; the essential feature of the 'rotary' is a long pipe rotating at high speed and carrying on its end a bit of suitable design. In the early days of rotary drilling it was customary to remove the fragments of strata—cuttings as they are called—by means of a stream of water which passed down the inside of the pipe carrying the bit, through apertures in the drilling bit, and up the annular space between the pipe and the walls of the hole. In wells drilled through clay or shale, the water in circulation became muddy and sometimes so viscous as to necessitate addition of fresh water and rejection of a part of the fluid in circulation, and it was noticed that this clay-laden water had many advantages over clean water as a circulating fluid and the use of a mixture of clay and water—termed mud-fluid or drilling mud—for rotary drilling is now a universally accepted practice.

The increase in depth to which wells have been drilled has brought with it a very great increase in the difficulties of drilling and within the last few years the need for finding the most suitable clay-water mixture for the conditions encountered has become more generally appreciated. The importance of drilling mud is illustrated by an instance in which over twenty-five thousand pounds were spent on the provision of drilling mud for a single rotary well, and it is evident that the properties of this 'mud-fluid' deserve the most careful investigation. The paper by Messrs Evans and Reid forming volume XXXII of the *Transactions* of the Mining and Geological Institute of India discusses the preparation and more particularly the testing of rotary drilling mud.

The aim of the writers has been to discuss experimental results obtained in the laboratories of the Burmah Oil Co., and to review the wide literature to which they have had to refer.

Drilling mud is usually made in a central plant for distribution to a number of wells; methods of manufacture are based either on churning or jetting or preferably a combination of these. A method of jetting often termed hydraulicking is useful in mixing up soft clays or shales; a high-pressure jet of water is forced on the clay face, and the resulting thin mud re-cycled until it reaches the desired consistency. In hopper mixers, there is a horizontal jet below an inverted cone, and ground clay or shale is fed into the mouth of the hopper, sucked down by the vacuum created by the jet, and so mixed intimately with the water.

The mud plant must also deal with the reclamation of used mud—especially desirable where the cost

* By P. Evans and A. Reid, published in the *Transactions* of the Mining and Geological Institute of India Vol. xxxii, pp. 1-263, 1936. Price Rs. 13 or 19s. 6d.

of fresh mud is high. Removal of sand and cuttings brought up during drilling is achieved by a settling ditch along which the mud flows, by passage over vibrating screens, or by centrifugal means. The vibrating screen is also useful in removing gas which becomes trapped in the mud when drilling through gas sands and may remain there with remarkable pertinacity. The simpler means of cleaning the mud are provided at all wells, and the more elaborate ones at important wells and in the central mud plant.

To obtain the best results, in both manufacture and use, adequate testing is required, and this subject is discussed at length in the paper.

Mud should be regularly weighed whilst in use in order to ensure that sufficient hydrostatic pressure is maintained at the bottom of the well and also because, when the properties of a mud are sufficiently well known, it is possible to specify a range of weight within which the mud is likely to have the desired characteristics. The weight (or more accurately, specific gravity) may be controlled by varying the proportions of solid and liquid or by varying the density of the liquid—*e.g.*, by using brine instead of water. To obtain muds of high specific gravity barytes or haematite is added.

Perhaps the most important test on a mud, and the one least understood, is the measurement of viscosity. Drilling mud in flow does not behave in the same fashion as a simple liquid such as water or oil. Whereas the smallest force applied to a true liquid in a long narrow tube will cause a slow flow, this is not so with drilling mud, which possesses a '*yield value*' which must be overcome before flow takes place. The resistance to flow depends not only on this initial resistance but also on the mobility of the mud, and consequently in place of a single number to represent viscosity it is necessary to employ the two expressions 'yield value' and 'mobility.' This type of flow is termed '*plastic* flow,' and the subject receives detailed treatment in the paper. It is pointed out that because the majority of writers on mud fluid have not appreciated the need for describing the flow of mud in terms of yield value and mobility much published work is difficult to interpret.

The paper then goes on to discuss viscometers used for measurements on mud fluids, and describes those employed in America, India, and elsewhere. For routine work in Burma and India a paddle viscometer has been extensively used; in this the force needed to rotate a small paddle immersed in the mud is measured by placing weights on a scale pan. Difficulties in operating the various viscometers are dealt with in brief, with frequent references to the relevant literature. Various factors affecting viscosity are illustrated by reference to actual examples of measurements by the authors and their colleagues.

The problems of the flow of mud in the circulating system of a well have received but little attention in the past and an attempt is made to indicate lines on which it might be possible to relate the physical properties of the mud to the pressures needed in the pumps which force the mud through the circulating system of the well. As the mud has to travel at high velocities for perhaps two or three miles in a very restricted space, the pump pressures required may be extremely high.

The next subject to be discussed is *thixotropy*, a phenomenon of fairly common occurrence but one which has not received the attention its importance deserves. Thixotropy refers to the property whereby certain muds will gradually set to a jelly-like mass but will return to a mobile liquid if agitated and again set to a jelly if allowed to remain undisturbed. The change from liquid to jelly and jelly to liquid may take place almost indefinitely. There has been considerable confusion in the literature between the variable viscosity shown in plastic flow and the changes in viscosity produced as a thixotropic mud sets to a jelly. Measurement of this important property of thixotropy is complicated, and control has not yet been satisfactorily achieved.

A fairly full treatment is accorded to the measurement of acidity and alkalinity ("pH"). In view of the manifold applications of pH in industry it is to be expected that pH of muds may be important in a number of respects, but so far experimental work is slight and not entirely satisfactory.

Other tests made on mud are more briefly discussed; salinity tests—to determine the amount of

salt in the mud - aid in the detection of small inflows of saline water from the formations drilled through; stability tests are very important, as unstable muds may lead to almost endless troubles in drilling. The amount of sand carried by a mud should be a minimum in order to reduce wear and tear on pump parts, and frequent checks on the sand content are recommended. The size of the particles composing the mud, the colloid content, the plastering power, the plasticity and various other properties receive consideration. Plastering power is an important, although little-understood, property which bears on one of the important functions of the mud - the building up of a sheath of clay on the surface of the formations drilled through.

There are numerous illustrations in the text, emphasis being laid on the graphical presentation of experimental results. The references are drawn from a very wide range, and the detailed lists of contents and the full indexes make it easy to turn to any of the subjects dealt with.

The paper provides an example of the way in which apparently minor technical details of an industry may give rise to prolonged scientific investigations, and also an example of the application of apparently quite academic enquiries to matters of industrial importance.

Allantoin and Cicatrization of Wounds

LARREY (1766-1842), the celebrated French surgeon of the Grande Armée, observed that the presence of larva of flies on the wounds or sores helped their cicatrization. This observation was only taken advantage of near about 1930 when Baer of Baltimore undertook to utilize these larvae in therapeutics. The technique recently studied in France in the laboratory of Professor Brumpt gave surprising results in the treatment of wounds and osteomyelitis.

This happy result is due to the production of diverse substances by the larva among which the first to be characterized was allantoin.

This diureide excereted by a large number of animals and plants is derived from the disintegration of nuclear proteins of organic cells.

Allantoin was discovered in 1799 in the Museum of Paris by Vauquelin in the amniotic liquid of cow, and it formed the active principle of "Comfrey", *Symphytum Officinale*, the plant renowned since middle ages for the treatment of ulcers and wounds.

Dr Macalister in 1912 first employed with success solutions of allantoin obtained from an extract of the root of above plants, but the small content (0.8%) of the active principle rendered this medicine costly.

Allantoin can now be prepared economically from uric acid (which is a commercial product) by oxidation with alkaline permanganate.

In a 0·5 per cent solution of this synthetic allantoin the dressings are soaked and placed on the wounds. In such troubles as gastralgia, ulcers of stomach and duodenum, allantoin as an internal medicine has also proved very successful.

The extract of larva brought up aseptically and crushed under sterilized water contains besides allantoin all the soluble products of the organism of these insects. Recently this is being employed in France and Dr Maurice has made a medicine which in certain cases is preferable to allantoin alone.

ALLANTOIN AND CICATRIZATION OF WOUNDS

The presence of amino acids is the cause of this efficacy because the employment of histidine, mucine, leucine and pepsine has recently become current in dermatology and in the treatment of internal ulcers.

Lastly Dr Robinson has applied with full success urea for the cicatrization of varicose ulcers, of extended infectious burns and the treatment of certain buccal and cutaneous infections. A sterilized solution of 2 per cent urea in compress frequently renewed has caused to disappear all pain and provoke in the tissues influx of blood which favoured the reparatory action. No direct microbicide effect has been observed but the abundance of leucocytes carried by the circulation of blood contributes to the rapid elimination of infectious bacteria.

The modest price of urea will certainly make it an easily available medicine.

Originally urea was extracted from the urine of herbivorous animals but since over 10 years it is obtained industrially on a large scale in Europe and in America synthetically either from calcium cyanamide or from ammonia and carbon dioxide.

Calcium cyanamide suspended in water is transformed by an acid to cyanamide which takes up one molecule of water and is transformed quantitatively to urea.

This last reaction takes place in presence of dilute sulphuric acid at 70°C. On the other hand ammonia and carbon dioxide form ammonium carbonate of which the dissociation in the heat and under pressure gives rise to urea with a good yield.

Urea is now actually found in the market at such price that agriculturists and horticulturists use it as nitrogenous manure. Its purification for medical use will not raise the price much higher. Thus urea which is formed by the hydrolysis of allantoin is the most advanced product of integration of proteins and its cicatrizing action could not be predicted *a priori*.

The progress of chemistry has permitted once more to disengage from the empirical recipe of the past the active principle. —*Nouvelles de la Chimie.*

New Preventive for Silicosis

Much interest has been aroused by the announcement that as a result of research work conducted by the Banting Institute in co-operation with the McIntyre Mine at Schumacher, Ontario, a discovery has been made which may lead to the prevention of silicosis.

The new method, which has been worked out by Dr Dudley Irwin, of Toronto University, under the supervision of Sir Frederick Banting, the discoverer of insulin, with the assistance of two officials of the McIntyre Mine, Dr W. D. Robson, a surgeon, and Mr J. J. Denney, a metallurgical Engineer, is based on the theory that by a chemical organic reaction quartz dust dissolves in the lungs and produces degeneration of those organs. The new remedy consists of the use of dust particles of metallic aluminium as a preventive and it is claimed that the aluminium delays the solubility of the quartz dust and thus prevents nodules from forming in the lungs. The researchers found that rabbits kept in a box containing quartz dust developed silicosis; but were immune when particles of aluminium were inhaled with that dust. The Academy of Medicine in Toronto, to which the paper on this discovery was presented, is responsible for the pronouncement that the work represents a most outstanding contribution to the history of silicosis research.

—*The Colliery Guardian*, June 25, 1937.

An Insectivorous Plant in Bengal

J. C. Sen Gupta

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Aldrovanda Vesiculosa Linn is a rootless, free floating, aquatic plant, and is of special interest due to its being insectivorous.

Though taken as a rare species with a peculiarly detached distribution, this rootless, aquatic, insectivorous plant has been recorded from many parts of Europe, *e.g.*, France, Italy, Germany, Russia, Poland, Hungary, Caucasia, etc., Eastern Australia and Japan.

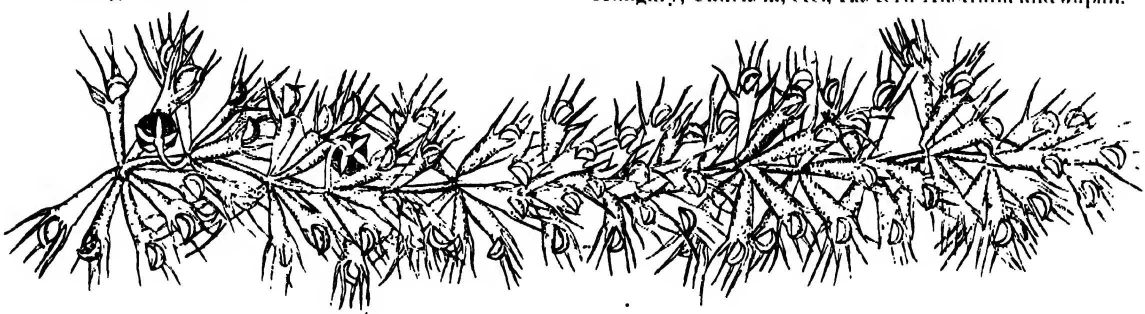


Fig. 1. A Complete plant, about 1.5 Nat. size.

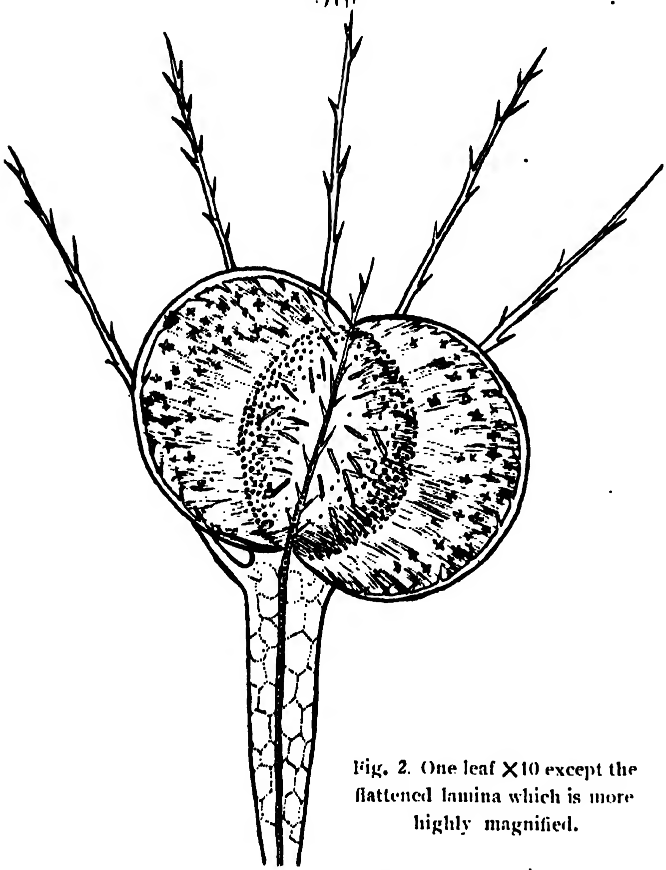


Fig. 2. One leaf X10 except the flattened lamina which is more highly magnified.

The first record of the plant from India is from Bengal by Roxburg in 1814 (published 1832) who does not say it is rare. Voigt writing in 1845 mentions his failure to find it near Calcutta though ten years later it was rediscovered by T. Thomson in salt pans south of Calcutta just to the north of Sundarbans area and again by J. Kurz in 1867 in the salt pans by Mutlah (Port Canning).

Since then there has evidently been no record of the plant from Bengal, though it was frequently looked for specially near Canning and Calcutta salt lakes in view of its special nature.

The writer discovered and collected quite a number of specimens of this plant, complete with flowers and fruits in the first part of August 1936 during a journey by boat at Dorabati and Baligaon between Tarpassa and Boloi and subsequently in October from Ontshahi, Silimpur and neighbourhood in Vikrampur in the district of Dacca. They were found growing quite commonly with *Utricularias*, *Hygrorhiza Aristata* Nees, *Myriophyllum* Sp, *Riccia natans*,

Riccia fluitans and other aquatic plants which usually grow vigorously at the area at this time of the year.

It seems probable that the plant had been growing in the area all the time without being detected. overflooding. It is likely to be found in all the low lying areas of Eastern Bengal, on submerged rice-fields. Roxburgh (1814) evidently recorded the plant from different parts of Bengal, but the more recent records (1855 and 1867) are from the neighbourhood of Calcutta, in the salt pans by Mutlah,

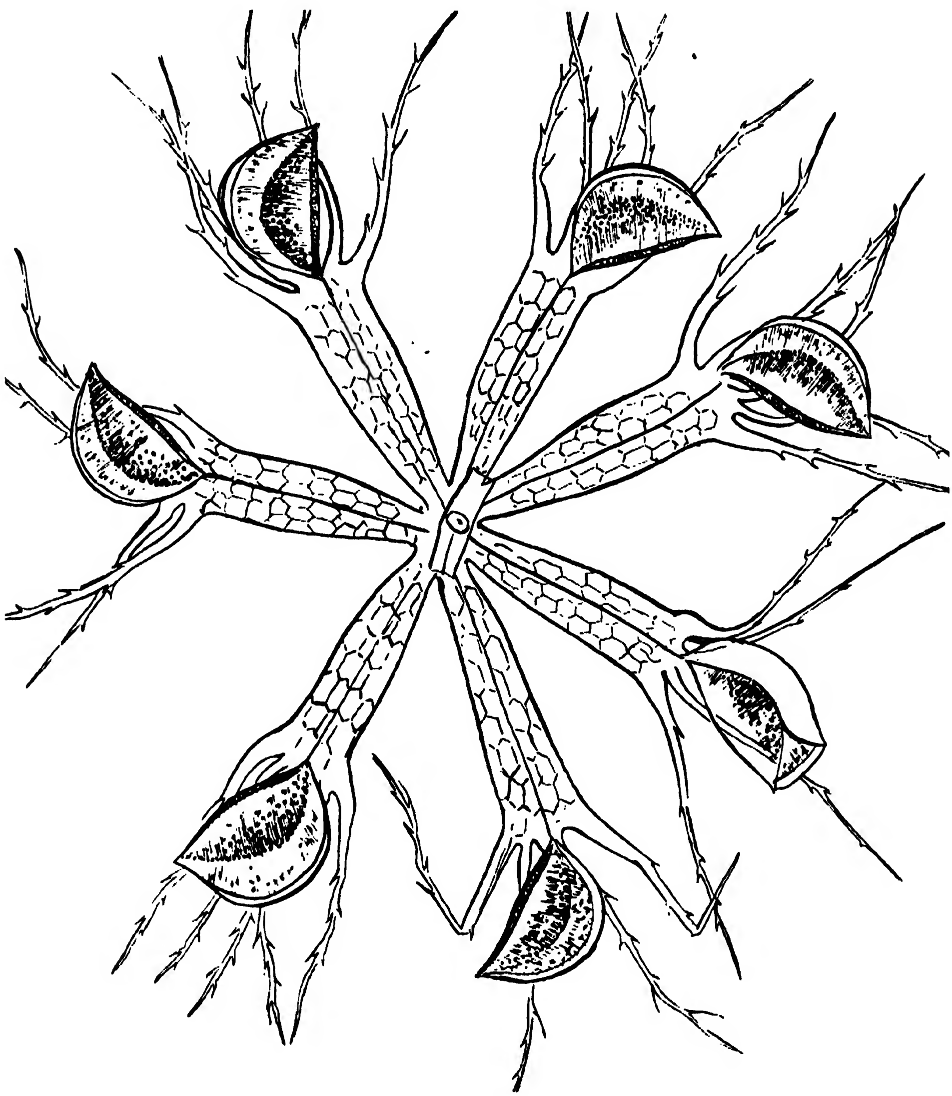


Fig. 3. A whorl of seven leaves ×10.

and it is evident that when water subsides in the dry season, the seeds remain in the rice fields at rest till they are submerged again at the advent of areas which have been more frequently visited by botanists, and where it seems the plant is not to be found now.

AN INSECTIVOROUS PLANT IN BENGAL

The reasons for the plant not being detected last seventy years seem to me due to the general look of the plant being not commonly known, and to the submerged parts of Eastern Bengal not being usually visited botanically at the time of the year.

To come to the actual description of the plant itself, the plants are found floating on the surface or just below, and are 6 to 9 cm. long (Fig. 1) and the length of the mature internodes varies between 4 and 6 mm. 7 or 8 leaves, (more commonly 8) are arranged in whorls round the stem and their broad petioles terminate in 4 or 5 (more commonly 5) rigid projections, each with stiff, short bristles (Fig. 3). The length of projection varies between 1 to 7 mm. (more commonly 5 to 6 mm.), and the broad petioles are 4 to 4.5 mm. long and about 1 mm. broad in the young plants found in August, which are rather delicate, pale yellowish green and slender and old plants in October are thick, swollen and darkish. The petioles in old plants (in October) become much stouter and darker, and longer, being 6.5 to 7 mm. long and about 2.5 mm. broad. The bilobed leaf lamina is at the end of this petiole and the midrib is tipped with a bristle and stands in the midst of projections (Fig. 2). The lobes are translucent and formed of very delicate tissue and in nature they are usually found in a closed condition. Each lobe exceeds a semicircle in convexity and contains two inner concentric portions next to the midrib and is slightly concave. The upper surface of this inner and lesser portion is studded with colourless glands which are more numerous near the margin and at the midrib. The glands are supported on distinct footstalks consisting of two rows of cells (Fig. 4). On this concave, gland-bearing portion of the lobes and midrib, there are numerous finely pointed hairs (Figs. 2 & 4), which, there can be little doubt, are sensitive to a touch and when touched cause the leaf to close. They have radial and basal articulations owing to which it seems clear they escape being broken when the lobes close. The total breadth of this inner portion of the flattened leaf lamina is about 2 to 3 mm. and the length of the midrib without the projection 2.6 to 3.2 mm.

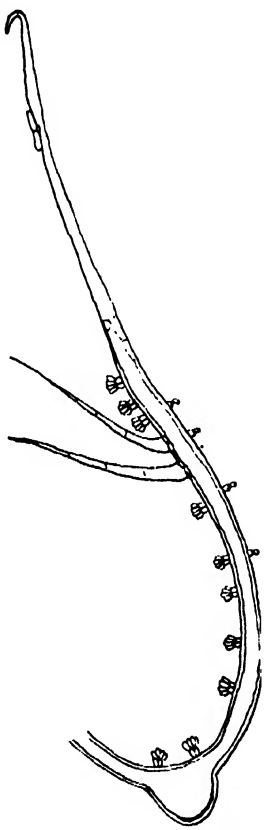


Fig. 4.
A cross section of a part of leaf lamina magnified about 60 times.

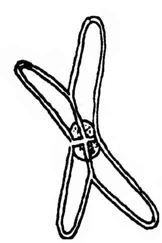


Fig. 5.
A quadrifid process of the outer leaf lamina magnified about 300 times.

The outer and the broader portion of the lobe is flat and very thin. There are no glands on their upper surface, but in their place there are small quadrifid processes (Fig. 5), each consisting of four tapering projections (Fig. 5) and sometimes three. The total breadth of the flattened leaf lamina is 3.6 to 4.5 mm. A narrow rim of the broad flat exterior part of each lobe is turned inwards and on the edge is found a row of conical, transparent, flattened points with broad bases like the prickles on a stem, so that when the lobes are closed, the exterior surfaces of unfolded portions come into contact (Fig. 2). The flowers are solitary, borne on the node from where the whorls of leaves originate, and the stalks are slightly bent upwards.

In October the plants are darker and in part decaying, and the flattened lamina falls out first, leaving the broad petioles, and mature fruits are common on the plants.

Notes and News

Relapsing Corrosion of Ancient Bronze and Copper

Conservators and collectors of ancient objects in bronze or copper are familiar with the curious phenomenon known 'as the malady of copper or 'pest of collectors."

One notices a wet spot of a bright green colour which appears on the surface towards the end of summer or during the first days of autumn. In consequence, the spot dries up and disintegrates after giving a bright green powder.

This corrosion takes place most frequently on objects imported from dry climates. Sometimes this corrosion imprints the form of a bright green afflorescence on bronze objects mechanically cleaned (scraped or engraved) and may cause the object to be fragile, and the loss may be irremediable.

Berthelot, who had studied this phenomenon, attributed it to the formation of hydrated oxychloride of copper, atacamite, produced in course of a primary reaction between copper, sodium chloride, and atmospheric agents. According to other authors, particularly Fink, the corrosion is attributed to the decomposition of atacamite in presence of humidity and carbonic acid. Recently, Fink and Polushkine have shown that whatever may be the intermediate copper products basic chloride or sulphate—it is the malachite (stable carbonate in presence of carbonic acid) which is formed.

—*La Nature*, 579, 3003.

Proposed Archaeological Activities in India

The Archaeological Department, it is reported, has before it a comprehensive programme of excavation to be undertaken at several mounds in the Punjab and United Provinces during the next cold weather season and the survey will include also some recent discoveries in Bengal and South India. Considerable interest is attached to the several mounds in the Punjab, especially in the Sheikhpura district, where pottery fragments, both painted and ordinary ware, have been discovered. Great expectation is entertained from the extensive mounds at Asrur and the site at Kala Shah Kaku, where painted pottery, beads and terra-cotta objects were found on the surface. Trial excavation is also proposed on some of the mounds in the south-east of the Punjab, the best known of which are those at Agroha in the Hissar District and Khokrakot near Rohtak. Dr E. G. H. Mackay on behalf of the American School of Indic Research will resume his operations this winter also.

Several important sites in the Saharanpur and Bijnore districts in the United Provinces have lately engaged the attention of the Department, and systematic exploration work is to be carried out there. Work is also to be resumed at Kausambi, one of the earliest historic cities, near Allahabad, and continued at Laur.ya Nandangarh, where finds of great importance have lately been unearthed under the supervision of Mr N. G. Majumdar.

Recently a site has been discovered in Bengal on the banks of the Damodar, near Durgapur in the Burdwan district, and the finds recovered there point to a pre-historic character of the place. Trial operations are proposed to be undertaken next winter.

Excavation work is also contemplated at several other places, *e.g.*, in the Madura and Tinnevally districts in the South. Field work is also waiting at several other places to be taken up at an early date, but the funds of the Department are unfortunately not enough to permit an extensive, country-wide survey, which remains on that account suspended till a later date.

The Maya Astronomy

We often come across reports regarding the greatness of the Maya science and of the civilization from early first millennium B.C. that existed in Central America before the Spanish Conquest, but these reports are mostly vague and at times exaggerated, though many authoritative accounts appear from time

to time, which throw a flood of light on these points. The latest article on this very interesting subject appears in *The Telescope,* May-June 1937, from the pen of Daniel Norman, and it "clearly pictures the knowledge that the Maya possessed both of mathematics and of the motions of the heavenly bodies." The Maya system of counting was vigesimal, *i.e.*, they counted by twenties and not by tens. In one year (called "Vague year" by the author) there were 18 months of 20 days each and a short one of 5 days, so that the number of days in a year was 365. They had also 20 day names. "A complete Maya date, consisted of the serial number of the day counted from a beginning date far in the past, the position of the day reached by this number in one of the months of a 365-day year, the position of this day in a permutation formed of twenty day names and thirteen numbers, and, finally, one of the nine Lords of the night." We have also confirmation, in the Maya records, of the practice of holding what is equivalent to an international astronomical congress in order to settle many points of discrepancy arising out of an endeavour to maintain a standard calendar. It is interesting to note that the Maya had devised astronomical instruments and used aids to naked eye observation. Their inscriptions go to reveal that they were accurate observers and knew the length of the tropical year to an amazing degree of accuracy, and that the Venus year was well known. "Eclipse and lunar tables, and ephimerides of Mars and Venus have definitely been identified in the Dresdensis; tables for Jupiter and Saturn have been tentatively identified and an ephemeris for Mercury has been suspected." And there are good reasons to believe that they stumbled across eclipse syzygies at a very early date.

The above synopsis shows that the Maya year was purely solar. The lunar cycle of month was not used. Thus the Mayas escaped the nonsoluble problem reconciling the solar year with the lunar year by means of intercalary months, as we find in the old world.

It is also noteworthy that instead of a cycle of seven days, each distinguished by the name of a deity, the Mayas had a cycle of 20 days, like the Egyptians who called each of the thirty days of the month by a different name. The practice of using a cycle of seven days is due to the Chaldean astronomers.

The Moscow-Volga Canal

The recent opening of the Moscow-Volga Canal was effected by the lowering of the gates of the new Volga dam which supplies water for the canal, assists the water supply of Moscow, and raises the level of the Moscow and Yanza rivers. Moscow has now become an important port in communication, for deep-water vessels, with the Baltic Sea, White Sea, and the Caspian Sea. It will also be directly connected with the Black Sea when the Volga-Don Canal will be completed.

According to note in *World Power,* the length of the canal from the Volga to the Moscow river is 80 miles. It is thus longer than the Panama Canal though requiring a smaller volume of excavation. The most interesting engineering feature of the Canal is the lifting of the water a few miles from the Volga over the watershed which rises very steeply to about 120 feet. The power required for working the centrifugal pumps for raising the water through the flight of docks was estimated at 300 million kWh per year. The idea of utilizing the fall between the Volga watershed and the Moscow river for a number of hydro-electric stations was due to a young Soviet engineer, A. I. Baumholtz, and has enabled 180 million kWh to be supplied for this pumping.

The Control of Raging Waters

American rivers are notorious for their destructive forces and for the ravages they cause yearly to the inhabitants of the regions through which they flow. When they are in flood they bring down great chunks of earth from the banks on both sides and carry these along with them. Banks are washed away by the rushing streams, and buildings, fences, roadbeds, and railroad bridge abutments are destroyed as the rushing waters eat the bank away. The loss every year is enormous, and the scientific mind in America was striving ceaselessly to find out a method that may successfully resist the erosion, until a plan was devised by a man (named Mark W. Woods) who owned some of these riverside farms along the Missouri and had watched them float away down the river. He took the leaf out of a patented scheme

of laying foundation stones in the river-beds, and applied it to this new field with such success that is subsequently gained universal application. He tied cottonwood trees in bunches with galvanized cable and hauled them by tractor and anchored them to the concrete piles sunk by the Bignall method. These acted as retards and forced the currents of the river into the main channel. The slowing down of the water caused sediment deposition. In a few weeks there was a mud flat where before water had been flowing.

A new method of permanent bank protection was thus demonstrated which was inexpensive compared with the results achieved and capable of very wide adaptation. A type of pile was developed for making solid concrete dike facing. One side has a V shaped notch and the other an inverted V to fit the opening. The piles are sunk side by side thus locked together. The work is rapid and permanent and comparatively inexpensive, considering that other types of protection are not permanent. Many miles of dikes on the lower Mississippi and Gulf Coast are now thus protected.

By wise planning for the control of flood, and restoring the underground water reserves we can control run off and prevent soil erosion and loss of fertility. America is seriously engaged in fighting the ravages of water. In India too, especially in East Bengal, the conditions are those of the American river basins; Bengal, like the latter, is continually in the danger of both inundation and drought. America has a national programme to check the evil, while India has none, owing mainly to the unscientific, and often apathetic, irrigation schemes of the Government of India. A wise and comprehensive planning on a scientific basis is required not only for the resuscitation of the dead rivers but also for irrigating dry lands, thousands of acres of which are lying waste which could otherwise be utilized with immense profit. Efforts should be made earnestly to make the river what it used to be—a source of wealth, power, and inspiration.

Indian Science Congress Association—Discussions

The following discussions have been tentatively arranged for the Jubilee Meeting of the Indian Science Congress:--

SECTIONAL DISCUSSIONS

Section of Chemistry: 1. Recent advances in the structure of alkaloids. 2. Chemistry and industrial development in India.

Section of Geology: 1. Pre-Cambrian sedimentation. 2. The originof banded geneisses. 3. Plateau basalts. 4. The significance of the 'Main Boundary Faults' of the Himalayas.

Section of Geography and Geodesy: 1. The teaching of geography in India.

Section of Botany: 1. The origin and relations of the Himalayan flora. 2. A national herbarium for India (in co operation with the Indian Botanical Society). 3. Algal problems peculiar to the tropics and especially to India.

Section of Zoology: 1. Animal ecology in relation to India. 2. The place of systematics and morphology in the study of the living animal.

Section of Anthropology: 1. Blood groupings and racial classification.

Section of Medical Research: 1. Immunity in protozoal infections. 2. Nutritional diseases in India. 3. Black water fever. 4. Cholera.

Section of Physiology: 1. Physiology of the individual in health and disease. 2. Diet and adaptation to climate. 3. Climate and its influence on the thy roid adrenal appratus.

Section of Psychology: 1. The contributions of abnormal psychology to normal psychology.

JOINT SECTIONAL DISCUSSIONS

Sections of Mathematics and Physics, and Chemistry: 1. Recent advances in molecular structure from the physico-chemical standpoint.

Sections of Geology and Botany: 1. Discrepancies in the chronological testimony of plant and animal fossils.

Sections of Botany and Agriculture: 1. The dissemination of cereal rusts in India. 2. The need for a central station for standard cultures of fungi in India.

Sections of Zoology and Entomology: 1. The position of Entomology in the Indian Universities.

Sections of Entomology and Agriculture: 1. Biological control of insect pests.

Sections of Botany, Chemistry and Agriculture: 1. The absorption of salts by plants.

Sections of Botany, Agriculture, Mathematics and Physics: 1. The importance of phenological observations in India. (In co-operation with the Indian Botanical Society).

Sections of Botany, Zoology and Agriculture: 1. The structure of the chromosome. 2. The species concept in the light of cytology and genetics.

Sections of Mathematics and Physics, Geology, Geography and Geodesy, and Agriculture: 1. River physics in India. (In co-operation with the National Institute of Sciences of India).

Sections of Chemistry, Zoology, Medical Research and Agriculture: 1. Colloids in Biology, Medicine and Agriculture.

Sections of Medical Research and Physiology: 1. Animals and their diseases in relation to man.

It is also hoped to arrange the following discussion:—

Sections of Zoology, Medicine, Veterinary, Research, Entomology and Agriculture: 1. The relation of Zoology to Medicine, Veterinary Science and Agriculture.

Members who wish to have summaries of their remarks printed in advance of the meeting should send the summaries to the Presidents of the Sections concerned not later than the 1st of October.

Fishery in Bengal

The fishing trade is Bengal is carried on on the ageold lines, and the latest scientific developments are absolutely unknown to the fishermen of the Province. But the market in that commodity is larger in this Province than anywhere else in India. In Calcutta alone 1 to 8 hundred maunds of fish are sold daily. The demand for fish has increased, it is reported, by over 40 per cent while the supply in the city has gone up by 25 p.c. only. Thus there is a vast field for the development and expansion of fish trade in this city, and also elsewhere in Bengal. Presiding over the Bengal Fishermen's Conference on July 10, 1937, Mr N. R. Sarker, Finance Minister, said *inter alia* "If prosperity increased in the land, then with an estimated fish-consuming population of about 4 crores and with a daily ration of a *chhatak* per head, Bengal would require 64 thousand maunds of fish per day. In money value, the annual amount spent would be somewhere near 23 crores of rupees at an average price of Rs 10/- per mound. The possibilities for development of the industry are therefore very large. In Madras where the fish-consuming population is far less than in Bengal the fishing industry with the help of the Government Board of Fisheries has made great strides in recent years." Sea-fishing has not been so far taken up by Bengal, mainly because it requires considerable capital. We agree with Mr Sarker that the amount of capital required is by no means such as to make it difficult to obtain it in this province. If sea-fishing could, as Mr Sarker pointed out, be carried on proper lines with modern appliances and modern methods of transport, etc., Bengal could, besides meeting her own demand, export fish profitably not only to places in Northern India but could also supply the Government's Military Department and even send exports outside India. Nor must the industry be thought to be limited to the supply of fish alone. With it, or rather as part of it, go certain allied trades and industries which also will prove very profitable. In Western countries, for instance, the bones, scales and intestine of fish are used in the preparation of gum, manure, etc., apart from the various fish oils prepared and put to various industrial uses. With proper guidance such industries can be developed in this country also.

A Guide to Indian Cottons

The East India Cotton Association Ltd., and the Indian Central Cotton Committee, Bombay, have jointly brought out a brochure, under the title of "A Guide to Indian Cottons", with a preface by Sir Purshotamdas Thakurdas, Vice-President of the Indian Central Cotton Committee. In view of the fact that Indian Cottons are attracting greater and greater attention in the world's markets, the 'Guide' will supply a long felt want. The information contained in it has the stamp of authority on it since it has been brought out with the kind and full co-operation of the several commercial bodies and the various Directors of Agriculture, all over India. The technical information given in the brochure was collected by the Technological Laboratory of the Indian Central Cotton Committee, situated at Matunga. A table of

the staple length, blow room loss and spinning performance of the various growths of cotton under average mill conditions is given at the end of the book which will be found very useful. Dealing with the characteristics of Indian cottons under Bengals, Broach, Oomras and Southerns in a detailed manner, the 'Guide' brings out the varying trade names by which they are known in different geographical districts where they are produced. This information is bound to be very useful to the consumers of Indian Cottons both in this country and abroad, in picking up cottons suitable to their particular requirements. The getup of the book is quite attractive and it can be had from the Secretary, Indian Central Cotton Committee, Post Pox No. 1002, Bombay. It is priced 6 annas.

Imperial Council of Agricultural Research: Annual Report

India has made remarkable advances in the development of agricultural and animal husbandry research during the last few years, according to the Annual Report of the Imperial Council of Agricultural Research for 1936-37. The value of this report is greatly enhanced by its early appearance.

Research schemes financed by the Council occupy a considerable part of the report. There is also much information regarding other lines of action. An outstanding feature of the year was the scientific stocktaking of the Council's research activities carried out by Sir John Russell, Director of the Rothamsted Experiment Station and Dr. N. C. Wright, Director of the Hannah Dairy Research Institute, whose reports are expected some time in August. The Council arranged for the representation of India by competent scientists at the Sixth World Poultry Congress held at Leipzig and Berlin and the Fourth International Locust Conference held at Cairo.

In the Council's popular bimonthly journal, *Agriculture and Livestock in India,* a series of illustrated articles entitled "Sons of the Soil" (Studies of the Indian Cultivator) dealing with the various peasant types in India has just started. An important event in the year was the meeting of the Animal Husbandry Wing of the Board of Agriculture and Animal Husbandry in Madras in December 1936. Out of this arose important recommendations regarding improvement in fodder and grazing which are likely to result in the establishment of Central and Provincial Fodder and Grazing Committees.

Turning to research, a mass of exceedingly useful work is reported to have been done. A chain of research stations subsidized by the Imperial Council of Agricultural Research deals with the many aspects of the breeding and cultivation of rice. In the United Provinces, a striking success has been the production of a hybrid which combines high quality with the possession of a protecting leaf over the ear which defends the grain against damage by the Rice Bug. In Bengal, a cross between a selected heavy-yielding Bengal strain and a foreign variety known as Blue Rose, has given progeny from which it is hoped to select a variety suitable for foreign markets. The Council also subsidizes a chain of sugarcane research stations. The work there done has given more exact knowledge regarding types of sugarcane suitable for particular areas, increase of yield, maintenance of juice purity and the combating of diseases. An extensive scheme dealing with insect pests of sugarcane in all provinces is under way and is being increased and intensified, particularly with respect to the finding of parasites to kill the insect pests. The manner in which wheat rust is carried over from year to year in India and how the spores are transferred from place to place has for some years been one of the important researches financed by the Council. It is hoped shortly to publish the full data. The breeding of rust-resistant wheats has been going on for some time in certain provinces in India and the Imperial Council of Agricultural Research is now financing a central scheme at Simla and Pusa to make the best use of the results obtained by the rust research.

An increasing amount of attention is being given year by year to fruit research. The well-known phenomenon of the heavy fruiting of the mango only in alternate years is being specially examined at the Sabour Fruit Experiment Station in Bihar. At Chaubattia in the United Provinces, the work deals mainly with hill fruits and particularly with problems of propagation, pruning and insect-pests, while in the Central Provinces, a scheme specially dealing with the well-known "Santra" orange has been started in the year under report. Cold storage of fruit has continued to be dealt with at the Ganeshkhind Fruit Experiment Station at Poona and

an important advance has been the extension of this work to gas storage of fruit and vegetables. A special officer was sent by the Imperial Council to Cambridge for necessary training in the technique of gas storage and he has returned to take up this work. Cold storage on a large scale has also been initiated by the Defence Department in certain Military Stations in Northern India. As the Imperial Council of Agricultural Research is interested in improved transport and storage of agricultural produce, it was decided that its services should be utilized in the organization of further research into the best methods of refrigeration both in store and in transport. The Government of India undertook to place the Council in funds up to about Rs. one lakh for this purpose.

It has been decided to attempt under the auspices of the Council to growing of a new crop in India, *viz.*, Pyrethrum, so important a source of insecticidal material.

The important work of watching the areas likely to be responsible for a locust invasion has been continued and it looks as if this activity might prove its great usefulness just now when there are some signs of recrudescence of locust-swarming in countries not far off from India.

Geological Survey in 1936

According to the Annual Report of the Geological Survey of India reports of 91 earthquake shocks were received by the Geological Survey during 1936, half of them from Burma, only 5 from Southern India, and the remainder from the Himalayan belt. Only one of these shocks, namely that at about 11-50 a.m. on the 27th May, was reported over a wide area; the damage was confined to slight cracking of buildings in the United Provinces and Nepal, but there was no loss of life. Slight tremors reported from Mettur in the Salem district, Madras, since the building of the great dam there, were also investigated, and the conclusion was reached that they were not due to the weight of water impounded in the dam and would have no effect upon the structure.

Discoveries of fossil, some of them of marine and pre-historic animals, in the Siwalik range of the Himalayan regions are also recorded and must give rise to interesting speculations as to what these regions were in the remote past.

Certain activities of the Department are of considerable economic intent. Special enquiries were carried out on the marble, slate and clay deposits of the North-West Frontier Province, gypsum in Garhwal (U. P.) and coal in Assam. Details are given of the minor coal-fields, suitable for local demands only, in the vicinity of Shillong. Attention is also drawn to the presence of a hidden coal field along the south of the Garo hills for which extensive exploration by boring is necessary before its true value can be estimated. Occurrences of other minerals were also examined by the Department, many of them unfortunately proving to be of no economic value. These were bauxite, copper corundum, felspar, gold, graphite, iron-ore, lead-ore, mica, nickel, oil-shale, road-metal, sapphire, sillimanite and steatite.

Many questions of engineering importance were also referred to the Department and its opinion asked for. The problems investigated included those presented by the high level of subsoil water of the Delhi Sewage farm; the site of the proposed Bhavani dam in the Coimbatore district, Madras; the water supply for St. Thomas Mount Cantonment, Madras; and the Jaba-Tangi irrigation scheme, North-West Frontier Province.

For geological survey purposes the whole of India and Burma is divided into four Circles, namely Burma, the North-Western, the North Eastern, and the Southern, the last three being in India.

In Burma mapping was done in the Thayetmyo, Kyaukse and Amherst districts and in the Southern Shan States. The tin areas in the Tavoy district were also visited and a traverse made from Mogok across the Mohgmit State to the Second Defile of the Irrawaddy. An important and interesting result of this traverse is the discovery of Cretaceous rocks in the Second Defile, the first recorded occurrence in Burma.

In the North-Western Circle geological surveys were undertaken in the South Waziristan Agency of the North-West Frontier Province, in Kashmir, in the Simla Hills, Punjab, and in the Dehra Dun district and Tehri Garhwal State, United Provinces. The survey in Waziristan was mainly a reconnaissance, which had to be carried out under armed escort, but a succession ranging from the Jurassic to the Upper Tertiary has been established.

In Kashmir the Survey was mainly concerned with investigations at the other end of the geological scale, from the pre-Cambrian to the Trias.

In the Simla hills and Garhwal, the survey was devoted to the elucidation of the "nappes" of the Himalayas, those immense sheets of rock which have been thrust horizontally for many miles over each other, the discovery of which in recent years has brought our knowledge of the Himalayan structure into conformity with that of the other new mountain ranges of the world such as the Alps and the Rockies.

Survey in the North-Eastern Circle was confined to Garo, Khasi and Jaintia Hills, Assam, where Cretaceous and Tertiary rocks rest upon the granite and old sedimentaries of the Shillong plateau and fall in a great monoclinal fold down the Cherrapunji scarp under the plains of Sylhet.

In the Southern Circle detailed mapping was carried out in the Nagpur, Chhindwara, Bhandara and Drug districts, and in the Baster and Jashpur States of the Central Provinces. Here the terrain has been found to consist almost exclusively of the ancient Archaean rocks which occupy much of the Peninsular India and from which most of its mineral wealth other than coal and iron is derived.

The provisional production figures for the year for some of the more important minerals are also given in the report. These are as follows:

Antimonial lead		1,240	tons.
Coal		20,497,108	,,
Copper		357,194	,,
Refined copper produced being		7,200	long tons.
Gold		331,389	ounces from Kolar, Mysore;
	and	1,294	ounces from Burma.
Iron		2,436,543	tons.
Lead		468,842	,,
Petroleum		333,968,768	gallons
Silver		5,952,000	ounces from Burma;
	and	28,959	ounces from Kolar (Mysore).
Zinc concentrates		78,807	tons from Burma.

With the exception of antimonial lead, zinc concentrates and coal, the fall in coal on the provisional figures being half a million tons, all these figures show increases over the production in 1935.

Indian Statistical Institute

A scheme for instituting examinations for the award of certificates and diplomas in statistics was sanctioned by the Indian Statistical Institute in 1936. Arrangements have been made for holding the first examinations under this scheme in Calcutta in December 1937.

The main object of the present scheme is to set up minimum standards of proficiency in actual practice of statistical computation and statistical analysis. The examinations will cover the requirements for two different types of workers:--Computers for routine calculations and for the collection of primary materials; andd Statisticians with adequate knowledge of both statistical theory and statistical practice.

Two examinations will be held in December 1937 for the award respectively of (1) Computer's Certificate Part I which will cover minimum requirements for posts of junior computers in agricultural stations, government offices, business firms, and scientific institutions, and (2) Statistician's Diploma Part I which is intended for officers and research workers who desire to acquire a general knowledge of modern statistical methods. It is intended to hold examinations for the award of Computer's Certificate Part II and Statistician's Doploma Part II in 1938 along with the examinations for the two junior certificates.

In order to maintain proper scientific standards the co-operation of statisticians from abroad has been secured for this work. Prof. A. L. Bowley (University of London), Prof. R. A. Fisher (University of London), Prof. E. S. Pearson (University of London), Dr A. C. Aitken (University of Edinburgh), Dr J. Wishart (University of Cambridge), and Dr J. O. Irwin (London) have kindly agreed to act either as examiners or moderators for the two examinations in 1937.

Copies of the Syllabus may be obtained on application from the Honorary Secretary, Indian Statistical Institute, Presidency College, Calcutta, on receipt of four annas in postage stamp.

Sir U. N. Brahmachari

Sir U. N. Brahmachari, M.A., M.D., PH.D., has been appointed chairman of the St. John Ambulance Association and Indian Red Cross Society with effect from July 17, 1937.

Science in Industry

A Bye-Product of Beet-Sugar Fermentation

During the sugar season, *i.e.*, from October to January, distilleries using beet-sugar for producing alcohol allow thousands of tons of carbon dioxide to escape in air, the value of which, if condensed in the solid form—dry ice—would be greater than that of the alcohol produced. In fact the productions of alcohol and this gas are equal and their values are quite comparable. One of the greatest difficulties which stood in the way of obtaining carbonic acid commercially was the problem of storage. The production is in full swing for three months whilst its consumption takes place throughout the year particularly during the summer months.

A recent installation in the distillery of a sugar-works in Meaux possesses the biggest reservoir of liquid carbonic acid. It consists of a reservoir 25 cubic metres in capacity and three of 56 cubic metres each, having a total capacity of 193 cubic metres. Every reservoir is furnished with two safety-valves, to allow for volatilization due to external heat. The external surfaces of the reservoirs are insulated with three layers of cork, 36 cm. thick, which is again covered with an insulated coating. With such an insulation the loss of heat at a temperature of 35°C is only 800 calories-hour for a reservoir of 100 sq. meter surface, as was amply shown during a strike in June and July of 1936, when the loss of the liquefied gas was inappreciable, though the reservoirs were left alone and the safety-valves were not in operation.

The liquefied gas thus stored under a pressure of 10 Kg and at a temperature of −40°C, is according to necessity allowed to expand in a chamber where it solidifies through expansion and pressed into blocks. Blocks of 16-17 Kg are thus obtained which are ready for transport and which are being used more and more in many industries displacing ordinary ice as a cooling substance.

Electricity for heating Soils

According to a note in the *World Power* extensive experiments are being carried out in Canada on electric soil heating during winter for agricultural purposes. The Hydroelectric Power Commission of Ontario have published some dtailed results of an experimental hot bed to which green house-raised radish, cabbage, and tomato-seedlings were brought early in February. All these plants, as well as a variety of flowering plants, were successfully reared and the total growing season lengthened.

The consumption during 23 days of February, including the preliminary heating, was 1.35 kilowatt-hours per sq. yard per day. During March the consumption was 1.5 kilowatt hours per sq. yard per day. The minimum temperature required to be maintained was 55°F. During February the minimum recorded temperature ranged from 6° to 30°F, and during March from 4° to 32°F.

In a certain American zoo, electrical cables have been used to heat the reptile house soil for the comfort of the snakes and alligators.

Indian Vegetable Oils

A work of reference on Indian vegetable oils is published today by the Industrial Research Bureau of Government of India.

This bulletin is a review of the different vegetable oils grown in India and is the work of Mr N. Brodie, the Director of the Industrial Research Bureau who is now on leave *ex* India. Mr Brodie has reviewed the characteristics of about 129 different vegetable oils which have been classified as drying oils, semi-drying oils and non-drying oils. The bulletin contains much useful information on the localities from which they are obtained and the uses to which they are put. Production and export statistics are also given.

It is remarked that the climate of India is well adapted to oil-seed production, and that India is one of the most important of oil seed producing countries. Though China is estimated to be the largest producer of oil seeds, statistics obtainable of produc-

tion in that country were unsatisfactory. India is regarded as the second largest producing country of vegetable oils. Exports of vegetable oils from British India are, on the average, about one million tons, but as internal consumption is also large, it is noted that there is no means of determining the total production.

The bulletin states,- "Vegetable oils find many uses in industry. They are used in large quantities for edible purposes, *e.g.*, in cooking and, in western countries, particularly for the manufacture of margarine. The second largest outlet for vegetable oils is in soap-making. Hard soaps are made from relatively saturated oils and soft soaps from highly unsaturated oils. Unsaturated oils are also of great importance in the paint and varnish industries. Many vegetable oils are used in medicine. In some cases they find a place in the pharmacopies of western countries. In other cases they may have considerable local reputation for the treatment of various diseases. Several oils, of which the most important is castor oil, are used for lubricating purposes either of themselves or in admixture with petroleum oils. In this respect, however, vegetable oils have lost much ground to petroleum oils. In the areas in which they are produced, vegetable oils are frequently used for burning, but here again have been largely replaced by petroleum products."

The ground has been thoroughly covered and even to those familiar with the vegetable oils of India much of the information in this bulletin will come as new. The bulletin, which contains both an index of botanical families, with species, and also a complete general index, may be obtained from the Manager of Publications, Delhi, at annas -|6|- per copy.

Fastness of Colours

We are glad to publish below an article on "Fastness of Colours" from the pen of Mr B. C. Bhattacharya, Principal, Govt. Weaving Institute, Serampore. It deals with the difficulty of defining properly the term *fastness* as applied to dyestuffs used in dyeing textiles, as it involves a large number of factors, *e.g.*, exposure to light, nature of the fabric, shade of the colour, etc. Yet it is necessary for the trade to have some sort of a standard definition so that the dealers may be sure how much they can guarantee and the buyers may know how much they can expect. The author also describes the attempts that are being made in the more advanced countries of the west, *e.g.*, Germany, U. S. A. and England to evolve a satisfactory and scientific definition of fastness.

Ageing of Power Condensers

Condensers of large dimensions are extensively employed for improving the power factor of A. C. systems. These condensers are not infrequently required to stand extremely high voltage. It had unfortunately been found that even with the use of the best materials the condensers used to age for no apparent reason. The cause of ageing has recently been traced to the formation of small air-bells inside the condensers. Since these air bells cannot be entirely removed an ingenious method has recently been developed in the Philips Research Laboratory for overcoming their deteriorating effect. This interesting work has been described in the following article on "Ageing of Power Condensers and its Remedy."

The Fastness of Colours

B. C. Bhattacharya
Principal, Government Weaving Institute, Serampore.

Introduction

Colouring matters have been used for decorative purposes in every country from the earliest times. The ancient mural paintings, examples of which are still in existence in many parts of the world, were executed in such naturally occurring mineral colours as were available to the artists of old. These colouring matters are known as "pigments." They are characterized by great stability and are usually insoluble in water. This latter property makes them generally unsuitable for application to textile materials.

For the colouring of textile materials, however, the ancients depended largely on colouring matters of vegetable origin. These are either soluble in water or can be brought into solution by some simple means so that the fibre may be dyed in a solution of the colour. This group of colouring matters is called "dyestuffs." It also includes a class of colouring matters which, though they have themselves no affinity for the fibre, may still be fixed on it by means of fixing agents which are technically known as "mordants."

The range of dyestuffs available to the earliest dyers was, of course, extremely limited. Many of them were fugitive to light. Of the comparatively fast dyestuffs known in India from early times, indigo is a typical example. Indigo plants were at one time extensively grown in many parts of India—particularly in Bengal and Bihar—and the colouring matter extracted from it. But during the last half a century synthetic methods have been developed which have made it possible to manufacture indigo on a large scale by chemical processes. This synthetic indigo has now practically completely ousted the natural product not only by virtue of its cheapness but also of its purity and uniformity of quality. In the same way, artificially prepared alizarine has now replaced the madder plant from which the colouring matter required for dyeing Turkey Red used to be obtained. At present the vast majority of dyestuffs in common use - some of them having quite outstanding fastness properties are made synthetically.

As the problems of fastness to be dealt with in this article arise only in connection with dyed textile materials the following remarks must be understood to apply to the group of colouring matters known as dyestuffs and to no other group.

Fastness Guarantees

Many reputable firms of textile manufacturers now market coloured piecegoods which are sold under a guarantee as to the fastness of the colours. If a customer buys such a "guaranteed fadeless" fabric and then finds that the fastness properties do not come up to the guaranteed standard he can make a claim against the retailing firm. And if the firm is a reputable one it will immediately replace the material or refund the price. The customer loses nothing except the trouble and expense of going back to the shop with the material. In actual practice, however, it has been found that, so far as goods made by reputed manufacturers are concerned, the proportion of such claims is very small, so that the retailer is able to make a handsome profit even allowing for the claims for refund. The public are, of course, required to pay a slightly higher price for the material in consideration of the guarantee.

This is the position so far as the public are concerned. Although this method of giving absolute guarantees may not present any serious trouble in the majority of cases, disputes may conceivably arise in other cases as to whether a particular sample of material comes up to the guaranteed standard or not. This is where the trouble begins. For the standards of fastness cannot yet be defined in precise terms. As a matter of fact, the term "fadeless"

is extremely misleading as the dyestuff which will not fade under any circumstances simply does not exist. From the scientific point of view, therefore, the giving of unlimited guarantees regarding the fastness of any colour is open to grave objection.

This question does not concern only the consumer and the retailer. It also affects the wholesale merchants, the manufacturers, the dyers, the bleachers and the dyestuff makers. When all these functions are carried out by different parties disputes may easily, and, in fact, do frequently arise as to the liability for loss or damage. In such cases arbitration becomes extremely difficult on account of the absence of any accepted standards of fastness. When it is borne in mind that the dyestuff maker, the dyer, the bleacher and the merchant may as often as not belong to different countries of the world the urgent necessity for having certain internationally agreed standards of fastness can be easily realized.

Factors Affecting Fastness

Unfortunately the fastness properties of a dyestuff when applied to textile materials do not depend on the nature of the substance alone. They are largely modified by various other factors such as the nature of the fibre, and mode of application of the dyestuff, the depth of the shade, etc. It may not be generally known that the same dyestuff when applied to different fibres such as cotton and silk or wool may show quite different fastness properties, so that it is impossible to specify the fastness of a dyestuff without reference to the fibre on which it is to be applied. The fastness of certain colours can be greatly increased by simple after-treatments subsequent to the process of dying. The depth of the shade also plays an important part in this connection. As a general rule the lighter shades fade more quickly than the deeper shades of the same colour. It is therefore no wonder that dyers are placed in a very difficult position when fashion demands the greatest fastness properties in the lightest of shades.

The fastness of a dyestuff is also affected by the use to which the dyed material is put. A dyed fabric if continually exposed to sunlight and rain will fade much more quickly than if it were used for indoor purposes only. Even the climate of a locality is not without its effect. It has been found that in tropical countries with a high relative humidity dyed materials fade much more quickly than in countries with a temperate climate. Certain injurious gases present in the atmosphere of congested cities and of manufacturing towns are known to have a particularly destructive effect on dyed materials. In some cases the fibre itself is affected—cotton exposed to the atmosphere and sunlight being particularly liable to attack. The products produced by the degradation of cotton are known to accelerate the fading of certain dyestuffs.

From the above the reader will have obtained some idea of the complexity of the problem. The difficulty arises from the large number of factors to be taken into consideration before any scientific standards of fastness can be set up. As if these were not enough, the fastness of a dyestuff is found to differ within wide limits according to the agency to which the fastness refers. For instance, a colour which may be fast to light may not be fast to bleaching. It is therefore necessary to take into account the fastness of a dyestuff applied to a particular fibre to different agencies such as light, bleaching, washing, perspiration, rubbing, etc. If a number of dyestuffs were arranged in the order of their fastness to these different agencies it would probably be found that the order is different in each case, which means that it is impossible to make any absolute statement regarding the fastness of a colour. Any statement which may be made should therefore be understood to be qualified.

Standards of Fastness

As the terms fast and loose as applied to dyestuffs are purely relative, the only way in which the degree of fastness of a colour can be expressed in precise terms is by reference to a set of standards. The problem, therefore, resolves itself to the setting up of a set of standards which will be acceptable to all parties concerned. It will be apparent from the above that in this connection one has got to take into account and define in precise terms the nature of the dyestuff, the nature of the textile material, the mode of dying, the depth of shade, the method of exposure and a number of other factors which affect the fastness properties of a dyestuff. When one bears in mind that the number of dyestuffs to be dealt with

in this way is very large it will be immediately apparent how arduous the work of testing all these dyestuffs is.

Scientific societies in various countries have been tackling this problem for the last few years. The German Committee were the first to publish the results of their work and to suggest certain standards of fastness. Since then the American and British Fastness Committees have also published their Reports. In the mean time the German Committee's recommendations have undergone several revisions. On the whole the recommendations of the German Committee appear to be more thorough and comprehensive than those of American and British Committees and are therefore more widely accepted.

According to this system the lowest degree of fastness is represented by the number 1 and the highest degree by the number 5. In the case of light fastness however, there are eight degrees of fastness, the highest degree being represented by the number 8.

Two tables are appended below which will make the meaning clearer:

For fastness to light the figures signify	*For other fastness properties*
1—poor,	1—poor,
3—moderate,	2—moderate,
5—fairly good,	3—fairly good,
6—good,	4—good,
7—very good,	5—very good.
8—excellent,	

For each of these standards precise tests have been suggested, so that there is no question of any uncertainty. The tests are such as to yield reliable results in the hands of different workers.

From the above it will be seen that it is now possible to dispense completely with such terms as "fast" and "loose," which are capable of conveying different meanings to different persons, and to indicate the actual degree of fastness by a number which means that the dyestuff will stand up to certain definite tests. This kind of statement is free from all ambiguity and therefore convenient for everybody concerned. Unfortunately, experts in the different countries have not yet reached complete unanimity regarding the tests and the system of notation. This is no doubt due to the extraordinary complexity of the problem. It is to be hoped that it will soon be possible to reach complete agreement as a result of further work now in progress in many countries.

Conclusion

This brings us to the question as to what the public may reasonably expect by way of fastness guarantees and what they may not expect. It is apparent that any kind of unlimited and absolute guarantee is quite out of the question. There is no colour which is absolutely fadeless under all conceivable conditions. In actual fact, even in the case of the fastest dyestuffs, slow fading is rather the rule than the exception. Many of us have noticed the slow fading of dyed goods after repeated washing. This is particularly noticeable in the case of light shades. Although the rate of fading may be greatly accelerated by careless or improper washing methods, it should be clearly recognized that some fading is inevitable even under the most careful treatment and with the fastest of dyestuffs.

But, unfortunately, there is no simple method of specifying any limited guarantee which will be easily understood by the public. The scientific method indicated above will not be understood by the public until they have been more thoroughly educated in these matters. In the mean time dealers will probably continue to use guarantees which have a selling value irrespective of their scientific implications.

While it is impossible to produce dyeings which are absolutely fadeless under all possible circumstances a range of dyestuffs is now available which can satisfy all reasonable demands. The public can expect the colour on a dyed material to stand normal use and washing during the normal lifetime of the fabric without any appreciable fading. It is quite possible to give such a qualified guarantee, provided the shade is not too light. Here again one is confronted with the difficulty of defining in precise terms the phrases "normal use", "normal life" and "appreciable fading". Alternatively, it might be possible for the manufacturer to guarantee that the material has been dyed with the fastest available dyestuff. Or, the guarantee may be limited to a definite period of time. But none of these methods are free from

difficulties and at present opinion is divided as to which is the best way of expressing the guarantee.

The success of any scheme of giving guarantees for the fastness of dyed materials depends on various factors. In the first place, the dyer must have a complete knowledge of all the materials he uses, such as the dyestuffs, the chemicals, the fibres to be dyed, etc. He must also have an idea as to the use to which the material is going to be put. Without this knowledge it is impossible for him to choose the colours properly. In the second place, the public must know the limitations of the dyeing and the dyestuff-making industries and not expect the impossible. In the third place, the public as well as the people connected with the trade in dyed materials should have a knowledge of the scientific method of specifying fastness properties which eliminates all ambiguity. In all the industrially advanced countries attempts are now being made to educate the public in these matters so that, by a mutual understanding of the difficulties involved, a more satisfactory service may be rendered to the consumer.

Ageing of Power Condenser and its Remedy

It is well known that alternating current in a circuit consists of an active or useful current and a wattless or idle current. The active current causes the motors to run and provides heating and lighting. The KWh meter indicates the consumption of this useful current. The wattless current is used only to magnetize the windings of motors and transformers, but does not produce useful work. For this reason wattless current is not registered by the KWh meter. If it is to be measured at all, a second meter must be installed—a reactive energy meter.

The power factor is an indication of the electrical efficiency of the plant. It indicates the relation between the active current and wattless current. If the power factor is, for instance, 0.6, this means that the active current is only 60% of the total current consumption. If the consumption of wattless current is reduced it is clear that the power factor will improve.

Although wattless current is unproductive, it loads and heats all components of the plant in exactly the same way as the useful current. Its presence necessitates an increase in size of the generators, transformers, switchgear and conductors. A bad power factor therefore causes increased expenditure. Further the presence of wattless current may also entail complication of a technical nature; inasmuch as it increases the current surges, and produces heat which damages cables and causes voltage fluctuations which motors and lamps cannot withstand.

This idle current may be due to inductive or capacitative loads. In actual practice electric power-stations are more subject to an unfavourable power factor due to inductive load than to a bad power factor due to capacitance. The idle current due to inductive load is said to be lagging and that due to capacitance is said to be leading in regard to the true current. As these two kinds of loads exert opposite influences on the phase angle, they can, if suitably adjusted, compensate each other's influence on power factors. This method of power factor improvement is extremely simple. The static condensers thus used for compensation of the power factor of an electric plant are usually called Power Factor Condensers.

The capacity and voltage of power condensers are practically unlimited now-a-days. Condensers of many thousand R. K. V. A., in power systems and for several million volts in surge voltage installations have proved their worth in practice. Although the modern condenser is entirely reliable, it has been found from experience that slow deterioration of the dielectric takes place which may continue for years before an actual breakdown occurs. The latest and

decisive stage in the development was the investigation as to the causes of this 'ageing', as it is technically called. Assuming the use of first-class materials both from the electrical and chemical points of view the cause of this 'ageing' has been found to be due to the formation of small air-bells (less than 1/100 mm. long). Even with the most careful evacuation these small air-bells cannot be entirely removed from the impregnating tanks of the condenser elements. These air-bells form the weak spots of the dielectric. In a homogeneous electric field, the strengths in the separate layers of the dielectric are inversely proportional to the dielectric constant E. For the oil impregnated paper the value of E is about four times as great as that for air. The smaller dielectric strength of the air-bells is consequently accompanied by a higher load. The air-bells which are already ionized at voltages which are not dangerous for the paper and the oil, start to 'glow', when subjected to over voltages. This causes chemical changes in the oil (polymerisation) which gradually changes into a waxlike mass whilst hydrogen gas is released. The paper fibres gradually become carbonized, and the condenser 'ages'. Since the air particles can never be removed, other means have to be found, of overcoming this deterioration effect. It is well known that the dielectric strength of a gas increases in approximately direct proportion to pressure. If, therefore, the air-bells are compressed a much higher voltage can be applied to the spools before ionization takes place. Thus when care is taken to keep the voltage well under the ionization point of the compressed air, the ageing effect may be greatly eliminated.

It has recently been announced by the Philips Research Laboratory that by utilizing this principle they have succeeded in designing condensers in such a way that this ageing effect has been considerably minimized.

The condenser spools are placed in a steel cylinder. The cylinder is filled for the most part with oil and for the rest with nitrogen under pressure of 300 pounds per square inch. The inert gas is used because it does not corrode the cylinder, has no chemical action on the impregnating oil and does not support combustion. The difficult problem of how to seal hermetically the current leads against the steel cap has also been satisfactorily solved by utilizing the chrome-iron to glass-welding process. The condensers manufactured on the basis of this principle are of extremely sturdy construction, and on account of suppression of ionization phenomena and of perfectly air tight sealing, the causes of 'ageing' have been completely done away with.

Adhesives from Wood

An affiliated concern of the German Dye Trust has developed an invention which promises to be of great importance for the paper-making industry. By this new patented process, a cellulose adhesive is now being produced in Germany from wood. This adhesive is not only a perfect substitute for flour-paste but as shown by the initial tests carried out in practice, it also possesses a number of other applications. For example, the new adhesive dries without creasing or warping, and makes an excellent binding medium for the two surfaces. The adhesive effect is not obtained by superficial pasting, but by a felting process so that even after drying and after a long period in hot, dry rooms the paper does not separate. Moreover, there is no risk of the glue penetrating thin paper.

Being a pure cellulose product, the glue neither affects the colour of the materials nor is there any danger of decomposition of the solution even if kept for a long time. As a result of these distinct advantages, the German paper industry is adopting this new adhesive to an increasing extent which in the view of the trade will have favourable effects upon the quality of the finished work.

—*The Chemical Age*, July 3, 1937.

Research Notes

Indian Scholars in Ancient Greece

Many scholars have drawn attention, from time to time, to remarkable similarities between the ancient Indian and the Greek schools of thought. The parallelism between Plato's doctrine of Ideas and Vedanta, the social classes in his *Republic* (*i. e.* Guardians, Auxiliaries, and Producers) and the Varnas of the Hindus, is specially noteworthy. So are the resemblances between the Eleatic and Sānkhya schools and between Orphism and Buddhism. Megasthenes, the Greek ambassador to the court of Chandragupta Maurya, remarks (302 B. C.) that the teachings of the Brahmans and the Greeks agree in many points, *e. g.*, the nature of God and of creation, the shape of the world, the immortality of soul, etc.

In an interesting note on this subject (*Indian Art and Letters*, *10*, 57, 1936) H. G. Rawlinson says that these resemblances have been hitherto dismissed as coincidences or instances of parallel but independent development of thought, in view of the fact that Herodotus explicitly states that the Greek doctrine of metempsychosis came from Egypt, and that contemporary proof of any nexus between cultured Greeks and Indians has hitherto been wanting. Rawlinson, however, quotes a remarkable passage from Eusebius (bishop of Caesarea in Phoenicia, 315-340 A. D.) which so long had apparently been overlooked by scholars. Here is the passage :

"Aristoxenus the musician tells the following story about the Indians. One of these men met Socrates at Athens, and asked him what was the scope of his philosophy. 'An enquiry into human phenomena', replied Socrates. At this the Indian burst out laughing. 'How can a man enquire into human phenomena', he explained, 'when he is ignorant of divine ones ?' "

Aristoxenus the musician (330 B. C.) was a pupil of Aristotle. So here we have contemporary evidence of the presence in Athens as early as the fourth century B. C. of Indians who knew Greek and actually discussed philosophy with Socrates.

On Cosmic Ray Showers

In 1934 Rossi (*Int. Con. Nucl. Ph.*, London, 1934 ; *Zs. f. phys.*, *68*, 164, 1931) made the interesting discovery that the cosmic rays in passing through matter produce many ionizing particles (showers) as secondary products. In his experiment Rossi counted the number of triple coincidences between three counters placed below a lead plate as a function of the thickness of the plate and observed a very rapid increase in the triple coincidences with the increasing thickness of lead, until, for about a one-centimeter thickness, a maximum was reached. Beyond this point the curve decreased, at first sharply and then very slowly.

Theoretical attempts had been made to explain this phenomenon of showers until it was believed that the ordinary quantum electrodynamics was unable to cope with this problem. Heisenberg in 1936, however, (*Zs. f. phys. 107*, 533, 1936) worked out a tentative theory for shower formation assuming the interaction between heavy (proton, neutron) and light particles (electron, neutrino) to be that given by Fermi's theory of β-ray disintegration. He found that for such processes the probability of ejection of several particles should be of the same order of magnitude as that of one, the Fermi coupling thus being responsible for the production of showers.

Inspired by the results of the latest experiments of Anderson and Neddermeyer (*Phys. Rev.*, *50*, 263, 1936) that the experimentally measured energy loss of fast electrons passing by a nucleus is in agreement with that predicted by the Heitler-Bethe's theory up to energies of 300 million e-volts, Nor-

dheim, Bhabha and Heitler, (*Proc. Roy. Soc.*, *159*, 432, 1937), and Carlson and Oppenheimer (*Phys. Rev. 51*, 220, 1937) have made fresh attempts to seek an explanation of the shower production in the quantum electrodynamics assuming that the primary cosmic rays are very fast electrons or positrons. They calculate the number of secondary positive and negative electrons produced by a fast primary electron passing through matter. The showers in this theory are built up by a succession of simple elementary process, the mechanism being as follows: the primary electron in the field of a nucleus has a large probability of emitting a hard light quantum which then creates a pair. The pair electrons emit light quanta again which create pairs and so on. The calculation shows that if, for example, electron of 10^{11} e-volts passes through a lead of 5 c.m. thickness the number of particles emerging from the plate amounts to 1000 or more. The theory successfully reproduces the nature of the curve as observed by Rossi.

R. C. M.

Vitamin B in Breads

The diet in the household of the unemployed men in the South Wales coalfields comprise little beyond white bread, butter or margarine, potatoes, sugar, jam, tea, and bacon. In order to see if such a diet could be much improved by the use of wholemeal bread, L. J. Harris (*Biochem. J. 31*. 799 1937) undertook animal feeding experiments to compare wholemeal bread with germ bread and bran bread (germ free wholemeal bread made by admixture of white flour with bran) with genuine wholemeal bread and with white bread. An accurate assay was carried out by the bradycardia method and the following conclusions derived.

Germ bread prepared from a mixture of 3 parts of white flour + 1 part treated germ was found to be only *little* superior to ordinary wholemeal bread although 7 to 8 times more potent than white bread. Again "without germ breads" or "bran breads" (*i. e.* "brown breads" containing the branny matter but with a minimum of germ) were superior to white bread in containing significant amounts of vitamin B_1 and contrary to expectation were not greatly inferior to genuine wholemeal bread or to "with germ bread" *i. e.* bread containing in addition the small proportion of germ present in the original whole wheat.

After this, some experiments were continued to obtain information about the vitamin B_1 content of the flours corresponding with the breads used in the experiments described above.

As with the corresponding breads, the "germ flour" has an activity similar to that of wholemeal flour. The reason for this is that the "germ" is less potent than has been supposed. This is confirmed by the direct assay of raw germ itself, whereas branny matter which is mainly responsible for the B_1 potency of wholemeal flour is also fairly rich in vitamin B_1.

H. N. B.

A New Phenomenon Occurring in Ionosphere

In October 1935 J. H. Dellinger gave a brief account of four occasions on which all high-frequency radio transmission throughout an entire hemisphere was suddenly silenced (*Phys. Rev. 11*, 705, 1935). He at that time pointed out that the effect occurred throughout the illuminated half of the globe only and not in the dark half, advanced the hypothesis that they depended on some solar emanation lasting only a few minutes, and suggested observations by workers of the possible occurrence of effects in terrestrial magnetism, solar radiations, earth currents and related phenomena. From this suggestion there grew up an extensive field of investigation upon these interrelated phenomena in which numerous individuals and organizations collaborated. Thus the data collected so far represent very extensive observations, a condensed summary of which by Dellinger himself appeared in the March issue of *Terrestrial Magnetism and Atmospheric Electricity* (Vol. 42, p. 49).

An analysis of the data immediately reveals the fact that the radio, terrestrial magnetism, earth current and solar effects are all simultaneous with

one another, and the whole phenomenon lasts usually from 10 minutes to an hour. The radio effect is the sudden cessation of high-frequency radio signals received from a distance, or the disappearance of echo pulses in ionospheric experiments. The terrestrial magnetic and earth current effects are the occurrences of a sudden sharp increase of a recorded element, followed by return to normal; the terrestrial magnetic effect is usually more marked in the horizontal intensity or declination. The solar effects are bright eruptions of the type regularly reported in the quarterly *Bulletin for Character-Figures of solar phenomena* from Zurich. It is also observed that the intensity of the effects is greatest in that region of the earth where the sun's radiations are perpendicular and diminishes to zero at the boundary of the illuminated hemisphere. They are also observed to be more intense in equatorial regions than in higher latitudes.

It is clear from the nature of the several terrestrial effects that they are caused by a sudden increase in ionization in some portion of the ionosphere, which in turn is caused by electro-magnetic radiation from a solar eruption. An increase in the ionization of a particular layer in the ionosphere causes increased absorption of the radio waves and diminishes the received intensity of waves which pass through the layer. The seat of the layer is found to be a region below the E layer, *i. e.*, less than 110 kilometers above the Earth's surface. It might possibly be one of the regions of the lower ionosphere, the D or C at 60 and 30 Km respectively, which were recently discovered at Calcutta (*Nature*, *135*, 653, 1935; SCIENCE AND CULTURE. *1*, 702, 1936). It seems that the agency which is responsible for the increasing ionization of the lower layer is different from that which causes the ionization of the recognized E_1, F_1, F_2 layers. The radiation emanating from area of sudden bursts on the sun's surface must, therefore, be of sufficiently penetrating character to pass through the upper layers and produce intense ionization in the layer of the lower ionosphere where the mean free path is short. The increased ionization, for this reason, disappears extremely rapidly on account of the larger value of the recombination coefficient.

The ionospheric disturbances and the associated effects are the only means of studying the nature of the radiations from solar outbursts because these do not reach the Earth's surface and cannot therefore be directly detected.

S. C. Deb.

South American Human Figures

Two human figures have been found in Bolivia in South America, one is that of a male and the other female. The male is made of stone and 10 inches in height while the female one is made of a kind of clay and 6¾ inches in height. The eyebrows of both the figures are prominent. The ears and nose are long and the form of the chin is square.

Cresswell Palaeolithic Artifacts

In the stone Age Gallery of the British Museum in January 1937, a special exhibition was held. There stone, bone and ivory artifacts excavated from the Pin Hole Cave and Mother Grundy's Parlour, Cresswell by L. Armstrong from 1923 to 1936, were shown.

Book Review

A Guide to Sarnath *by B. Majumdar, Superintendent, Office of the Director General of Archaeology in India. With an introduction by Rao Bahadur K. N. Dikshit. Delhi, Manager of Publications, 1937. pp. xv + 122 and 16 plates. Price Re 1-12 or 3s.*

Mr Majumdar, who was known to us as the author of a Bengali Guide to Sarnath officially published in 1928, has now produced an English account of the Buddhist ruins at Sarnath for the use and guidance of the visitors to this site of great archaeological interest. The present book, though following the same plan as his earlier Bengali book, is entirely independent of the latter and contains a good deal of fresh matter. The book is divided into four chapters : the life of Buddha ; the history of Sarnath, including art ; the monuments ; and the museum. The description of the last occupies more space than any other chapter, and naturally so, as the museum is more interesting to the casual visitor than the structural remains. Mr Majumdar sometimes attempts new interpretations of the symbols of Indian art and iconography, as those on the lion capital of Asoka, which deserve attention. His esoteric explanations of the Brahmanical gods seem to be a bit out of place in a book of official archaeology, but will prove to be of interest to the average reader.

Altogether Mr Majumdar may be congratulated on having produced a book which will admirably meet the requirements of those for whom it is intended and there is no doubt that his well-written work will supersede other similar previous publications, official or otherwise.

The Kharias—*By Sarat chandra Roy, M.A. and Ramesh Chandra Roy, M.Sc. With a Foreword by Dr R. R. Marett, M.A., D. Sc., LL.D., F.B.A. Published from "Man in India" Office, Ranchi, 1937, Price Rs 10/- Vol I & II p.p. 306 + 224 - 530*

This is another fine achievement of the grand old man of Ranchi, Rai Sarat Chandra Roy Bahadur, the eminent anthropologist of India. Chota-Nagpur and most of the eastern slopes of the Vindhya-ranges, being comparatively barren and inaccessible, have always escaped the disastrous convolutions of Indian political changes. Thus many of the oldest aboriginals found safe shelters in the wild recesses of the valleys. There in their comparative seclusion unhampered by the onslaughts of the growing civilization, the people preserved the purity of most of their original manners, habits and beliefs. These places therefore present a vast field of activity to the anthropologist, and Rai Bahadur Sarat Chandra Roy, the pioneer in Indian anthropology, took up in right earnest the systematic study of the people.

These two neat volumes practically form a part of the Rai Bahadur's series of anthropological publications on the tribes of Chota-Nagpur hill tracts. We get here a clear idea of the manners and customs of these people, their ideas of government and social control growing in an almost unalloyed form in spite of their being surrounded by superior civilizations. The careful anthropometric study given in the book will prove most helpful in the study of Indian races and racial discriminations, and will clear our views about the original migration of races in India. The folklore and myths, dances, music, amusement and games, and other recreations of daily life are not only interesting, but will also be considerably helpful to the students of anthropology to understand human nature in its movements, its tendencies and prospects.

There are a few, though negligible, printing errors, but the getup, printing and illustrations are good.

Minendranath Basu.

Letters to the Editor

Magnetic Properties of NiO

Nickel oxide was prepared by slowly oxidizing nickel amalgam in air. The amalgam formed at current density (I) gave a greenish oxide, while the amalgam formed at a higher current density (II) gave a greyish black oxide. The room temperature magnetic susceptibility ($\varkappa$) for oxides (I) and (II) were respectively found to be 106·7 and 153·4* in a field of about 6000 gauss. The temperature-susceptibility curve exhibits a sudden drop in the neighbourhood of 350°C which is very near to the Curie-point for metallic nickel. $\varkappa$ also diminishes with increasing field. This effect shows that oxide contains metallic nickel. The results are thus in agreement with the properties of NiO prepared by different means as observed by Klemm and Schuth[1]. The drop at 350°C incidentally points to the fact that the Curie point for metallic nickel in a fine state of subdivision is lower than the metal in bulk. The metal is perhaps in a colloidal state.

The oxides were heated to about 900°C for different durations. The corresponding changes in susceptibility are given below.

	Duration of heating	Temperature	Susceptibility.
Sample I	1½ hrs.	33.5° C	20.1
	1½ „	34°C	13
Sample II	1¼ „	33 5° C	17.3
	1¼ „	33°	15.3
	1¼ „	33°	13 5

The temperature effect for sample II was taken at this stage, the value showing an increase up to 220°C (14.5 to 15.7) and thence a decrease. Both the samples were heated for a further period of 4 hours, and the temperature effect observed. The results are given below,—

T°C	34·3	131	197	269	329	374	404	428
$\varkappa$	9·73 /	10·14	10·86	11·53	11·66	11·64	11·36	11·29

$\varkappa$ thus does not go on increasing with temperature as found by Klemm and Haas[2]. up to 350°, *i. e.*, the point to which increase is maintained in our case, our values are in very good agreement with theirs.

In units of 1×10^{-6}.

It is thus seen that NiO in the amorphous state has not a very well-defined $\varkappa$ value, which is higher than the value for the material in the crystalline state, this latter appearing to be much more well defined.

Indian Association for the Cultivation of Science,
Calcutta.
25. 6. 37.

D. P. Roychoudhury.
A. K. Bose.

1. *Zeit. f. anorg. u. allg. chem.* 210, 33, 1933.
2. *Zeit. f. anorg. u. allg. chem*, 219, 82, 1934.

On a Certain Point in the Proof of Kirchoff's Law

That radiation emitted by the wall of a uniform temperature enclosure at any point inside it is the same everywhere *i.e.*, independent of the position of the point with respect to the walls of the enclosure[1]—a point arising in connection with the proof of Kirchoff's Law, and usually not analytically d alt with - can be proved formally as follows: Take a very small sphere made up of symmetrically disposed component surface elements

$$dS_1, dS_2, dS_3 \ldots, dS_n,$$

each equal to dS, numerics indicating different compositions of the respective portions. Let ${}_1a_\lambda$, ${}_2a_\lambda$, ${}_3a_\lambda$, etc. be the respective absorption coefficients of dS_1, dS_2, etc, for λ. For a particular position of the sphere inside the enclosure, let the emission-coefficients of the enclosure be respectively ${}_1e_\lambda$, ${}_2e_\lambda \ldots {}_ne_\lambda$ at the different spatial points occupied by $dS_1, dS_2, \ldots dS_n$ ..

Then heat received by the sphere at the given initial position is proportional to

$$dS_1 \int {}_1a_\lambda \, {}_1e_\lambda \, d\lambda + dS_2 \int {}_2a_\lambda \, {}_2e_\lambda \, d\lambda +$$

$$dS_3 \int {}_3a_\lambda \, {}_3e_\lambda \, d\lambda + \ldots + dS_n \int {}_na_\lambda \, {}_ne_\lambda d\lambda$$

$$= K \text{ (say). } (1)$$

If now the sphere be rotated about the axis of symmetry (with respect to component elements) so that dS^n comes to occupy the former position of dS_1, and dS_1 that of dS_2, and so on, then since for temperature equilibrium the heat received must be the same for all positions of the sphere, we have, remembering that ${}_1e_\lambda$, ${}_2e_\lambda$, etc., are proper-

ties of space, and ${}_1a\lambda \ldots {}_1a\lambda$, etc. properties of the spherical body, (shape and size of the enclosure remaining unchanged),

$$dS_n \int {}_n a_\lambda\, {}_1e_\lambda\, d\lambda + dS_1 \int {}_1a_\lambda\, {}_2e_\lambda\, d\lambda + \ldots$$

$$+ dS_{n-1} \int {}_{n-1}a_\lambda\, {}_n e_\lambda\, d\lambda = K \qquad (2)$$

Subtracting (2) from (1) and arranging ,we obtain

$$dS_1 \int {}_1a_\lambda ({}_1e_\lambda - {}_2e_\lambda)\, d\lambda + dS_2 \int {}_2a_\lambda\, ({}_2e_\lambda$$

$$- {}_3e_\lambda)\, d\lambda + \ldots + dS_{n-1} \int {}_{n-1}a_\lambda ({}_{n-1}e_\lambda - {}_n e_\lambda) d\lambda$$

$$+ dS_n \int {}_n a_\lambda ({}_n e_\lambda - {}_1e_\lambda)\, d\lambda = 0 \qquad (3)$$

The parameters ${}_1a\lambda$, ${}_2a\lambda$ etc. are at our disposal, so we may assume,

$${}_1a_\lambda > {}_2a_\lambda > {}_3a_\lambda > . \qquad {}_na_\lambda.$$

Hence, sum of the first $(n\text{-}1)$ integrals ($\because dS_1 = dS_2 = .. = dS_n$) must be greater than

$$dS \int {}_{n-1}a_\lambda ({}_1e_\lambda - {}_n e_\lambda) d_\lambda \;(\because \text{ all but } {}_n a_\lambda \text{ are greater than } {}_{n-1}a_\lambda)$$

$$> dS \int {}_n a_\lambda ({}_1e_\lambda - {}_n e_\lambda)\, d\lambda.$$

Hence for (3) to hold, ${}_1e_\lambda = {}_n e_\lambda \ldots .$

Similarly, by suitable modification of the inequality relations or by further rotations, it could be proved that ${}_1e_\lambda = {}_2e_\lambda = {}_3e_\lambda$, etc.

Indian Association for the Cultivation of Science,
Calcutta.
B. Mukhopadhyay.

17.6.37

1. *Heat*, Saha and Srivastava, 1931, page 503

A Note on the Effect of the First Mating on the Fecundity of the Pulse Beetles

The pulse beetles are polygamous ; and frequent matings occur. The males seek the females, and pair with the nearest one accessible, evincing very little choice as to the selection of partners, the females playing the passive part. The mechanism of the reproductive apparatus has been described by us[1] (1937) and the mating habit by Zacher[2] (1930). In our examples of *Bruchus quadrimaculatus* Fabr., infesting the stored pulses and reared in the laboratory under the ordinary room conditions, the pairing commences soon after the emergence of the imago, and copulation which takes place in the day time, lasts for 25 seconds to 3 minutes. Egg laying begins within twelve hours of the first mating, and continues on an average for five days or more if the females live longer. Eggs are laid in batches and at intervals during which fresh copulation takes place. The maximum number of eggs is deposited on the first day, or the second day of emergence ; and the subsequent number of eggs laid daily decreases with advance in age as shown by Larson and Simmons[3] (1923). Larson and Fisher[4] (1924) are of opinion that the frequent mating such as occurs under storage conditions diminishes the longevity and affects productivity. Zacher (1930) reports that a single male of *Zabrotes subfasciatus* Boh., successfully mated, at least, with five different females on successive days, and showed sexual vigour for a week. He doubts, however, whether a female which copulated only once could lay the normal number of eggs.

To determine the question *Bruchus quadrimaculatus* Fabr., reared on *Phaseolus mungo* in the months of May and June 1934, were kept from the egg stages onward, separated from one another. Just as a male and a female emerged they were brought together, and after a single act of sexual union, they were isolated again. Several observations were made on different pairs, and on an average the life-history was completed in 28 days. The results are tabulated below. O indicates the total number of eggs laid by the female which mated only once, M and F respectively the number of males and females hatching out of these eggs and N the number of non-viable eggs, *i. e.*, that did not develop. The number of readings are shown in the left column.

	O	M	F	N
1.	75	30	34	1
2.	69	16	14	39
3.	67	32	25	10
4.	56	32	21	3
5.	40.	17	15	7
Average of a single female	61.4	25.4	22	12

Therefore viable eggs are 77.1%, males 41.3% and females 35.8%.

A control experiment the results of which are given below was made with identical conditions but the pair were

not separated after the first copulation and were kept together for free and normal number of matings. Hence O indicates, in the table, the total number of eggs deposited.

	O	M	F	N
1.	75	21	12	42
2.	61	17	12	32
3.	59	14	13	32
4.	58	18	11	29
5.	32	13	16	3
Average	57	16.6	12.8	27.6

Therefore, viable eggs are 51.5%, males 29.1%, females 22.4%.

The control experiment was repeated with two pairs instead of one, to facilitate random mating. The results are given below.

	O	M	F	N
1.	121	51	46	33
2.	86	34	29	23
Average of a single female	51.7	21.2	18.7	14

Therefore viable eggs are 77.1%, males 41%, females 36.1%.

Similar observations were made by isolating females after the first, second and third matings on successive days. Again a virgin isolated for a week from its date of emergence, did not deposit any egg during this period, but later on, being mated laid 23 eggs. The details will be published elsewhere.

The data given above although insufficient for making a definite conclusion, nevertheless, tend to show that a single mating soon after the emergence, does not affect the fecundity or the fertility of eggs.

Department of Zoology, Calcutta University. D. Mukerji. M. A. H. Bhuya.

30. 6. 37.

1. SCIENCE AND CULTURE, *1*, 1936. *Proc. Ind. Sci. Congr.* (Zoo. Sec), 1936. *Journ. Morphology*, Philadelphia, *61*, 1937.
2. *Arb. Biol. Reichanstlt. Land. Forswirst*, *18*, 1930.
3. *Journ. Agric. Research, Washington*, *26*, 1923.
4. *Ibid*, *29*, 1921.

On the Photo-iodination of Phenylacetylene, Di-Cyclopentadiene and β-Amylene in Wave lengths 546, 436 and 366 $\mu\mu$ in solvents of Carbon Tetrachloride and Benzene

During the last few years extensive researches have been carried out on the photo-chlorination and photo-bromination of various substances. But up till now, instances of photo-iodination of organic substances are rarely found in the literature. The object of the present investigation is to study, in details, the kinetics of photo-iodination of phenyl acetylene, di-cyclopentadiene and β amylene in various frequencies, *e.g.*, 546, 436 and 366 $\mu\mu$ in solvents of CCl_4 and C_6H_6. In all the cases, the following peculiarities were observed:

(1) The reaction is unimolecular with respect to iodine.

(2) The unimolecular velocity constant increases with increasing concentration of iodine so long as the absorption is not complete. When the absorption is complete, further increase in iodine concentration diminishes the velocity constant.

(3) The velocity constant increases with increasing concentration of the acceptor molecules.

In fact the reciprocal of velocity constant plotted against the reciprocal of concentration gives straight lines.

(4) The temperature coefficient is almost unity.

(5) The velocity constant is proportional to the square root of the intensity of radiation absorbed.

(6) The velocity constant increases for diminishing thickness of the reaction cell.

(7) There is an equilibrium in cases of di-cyclopentadiene and β – amylene. The equilibrium constant was determined and was found to diminish with diminishing intensity.

(8) The quantum efficiency is high. A chain mechanism is suggested. Further work is in progress in this line.

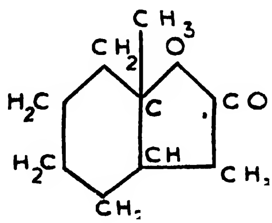
Chemical Laboratory, The University, Dacca. J. C. Ghosh. S. K. Bhattacharyya.

22. 6. 37

Synthesis in Hydro-aromatic Series. Phenanthrene Derivatives with Angular Methyl Group

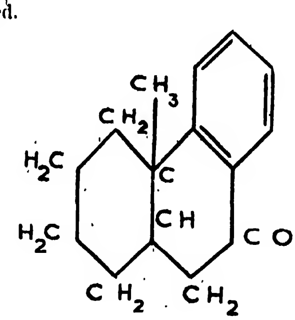
The method laid down in the author's previous communications[1] has been applied with success for the synthesis of phenanthrene derivatives with an angular methyl group.

The lactone[1,2] (I), methyl hexa-hydro-α coumaranone, obtained by treating ethyl cyclohexanone-2-acetate with methyl magnesium iodide, was condensed with benzene in presence of aluminium chloride.



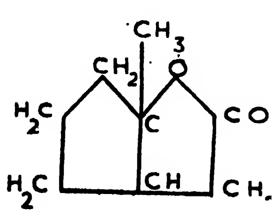
(I)

The resulting compound, 2 phenyl-2 methyl cyclohexyl-1-acetic acid m. p. 118-119° (with previous shrinking) was treated with 85% sulphuric acid, when the ketone, 10 keto, 11 methyl 5 : 6 : 7 : 8 : 9 : 10 : 11 : 12 octahydro phenanthrene (II), the semicarbazone of which melts at 201-202°, was obtained.



(II)

The semicarbazone on treatment with sodium ethoxide gve an oil[3] which was dehydrogenated with selenium to phenanthrene.



(III)

Methyl cyclo-pentano lactone (III) b. p. 96-97 (3.5 m.m.), prepared from ethyl cyclopentanone-2 acetate by Grignard reaction was condensed with benzene and 2-phenyl-2-methyl cyclopentyl-1-acetic acid m. p. 85° (ethyl ester b. p. 160-165/5 m. m.) was isolated.

My best thanks are due to Sir P. C. Ray for his kind encouragement in this investigation.

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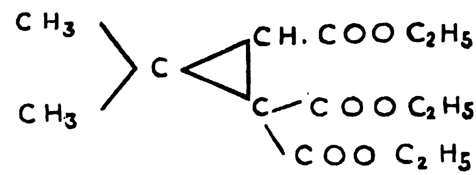
17. 7. 37.

1. Ghosh, SCIENCE and CULTURE, *1*, 229, 1935; 3, 55, 1937
2. Braun and Munch, *Annalen*, *465*, 52, 1928.
3. Cf. Kon, *J. C. S.*, 1081, 1933.

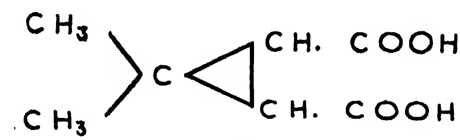
A new Synthesis of Caronic Acid

This acid has been synthesized by Perkin and Thorpe[1], Kotz[2], Farmer and Ingold[3], Kon and his coworkers[4], and recently by Guha[5].



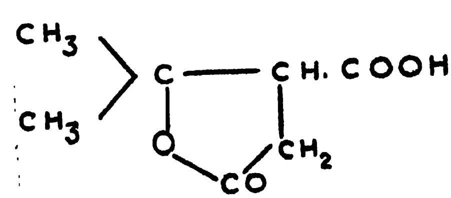
(I)

The present paper describes another synthesis of caronic acid by the following method.



(II)

Ethyl $\alpha\beta$ dibromo $\beta\beta$ dimethyl propionate[6] obtained by the addition of bromine to ethyl $\beta\beta$ dimethyl acrylate, was allowed to react with ethyl malonate in presence of sodium ethoxide and ethyl 2, 2 dimethyl, 1, 1, 1′ cyclopropane tricarboxylate (I) b. p. 142°-146°/5 m. m., 153°/9 m. m. was isolated. The ester on hydrolysis with alcoholic potash gave 2, 2 dimethyl cyclopropane 1, 1, 1′, tricarboxylic acid which on decarboxylation gave caronic acids (cis and trans) (II).



(III)

The hydrolysis of the ester (I) with hydrochloric acid took a different course and the lactonic acid, terebic acid (III) resulted from it with elimination of carbon dioxide and fission of the cyclopropane ring. Terebic acid (III) was

also obtained by boiling caronic acids with concentrated hydrochloric acid.

My sincere thanks are due to Sir P. C. Ray for his kind encouragement in this investigation.

Palit Laboratory, Ranajit Ghosh.
University College of Science,
Calcutta.
17. 7. 37

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2. Kotz, *J. Pr. Chem.*, **(2)**, **75**, 501, 1907,
3. Farmer and Ingold, *J. C. S.*, 1362, 1920.
4. Kon and his coworkers, *J. C. S.*, 1316, 1921.
5. Guha, *Current Science*, **5**, 388, 1937.
6. Prentice, *Annalen*, *292* 273.

On the so-called 'Coulsonite'

In the February issue of the ***Trans. Mining & Geol. Inst. of India***, 1937, Dr Dunn and Dr Dey have published a paper in which they have described the discovery of a mineral allied to magnetite but containing a relatively high quantity of vanadium which they have named "coulsonite." This discovery was announced last year in newspapers also.

That vanadium is present in Indian ilmenite-magnetite in quantities (nearly 5%V) far greater than that found elsewhere in the world was first observed by me and my pupil, Mr N. Ray. Mr Ray read a paper on the same subject in the Indian Science Congress (Chemical Section) in January 1932 (Vide *Proc. Indian Science Congress*, 1932. p. 212).

Dr Dunn cursorily mentions the name of N. Ray in the introduction of his paper on vanadium bearing titaniferrous iron ore (***Trans. Mining & Geol. Inst. of India.*** February, 1937) as follows:—"In 1933, the Oriental Export and Import Company sent some specimens from Dublabera to the Geological Survey with the information that they contained vanadium. The presence of vanadium had been detected in the ore by N. Ray whilst analysing material submitted to the University College of Science."

It should be stated that it was not a question of simple detection or the analysis of one or two samples but a series of investigations were carried out in 1931 on over 30 samples in which the V_2O_4 content varied from 0·5 to 8·8%. Further, the excavations in Dublabera region were made according to my suggestion by the Oriental Export and Import Company.

That due recognition for this discovery was apparently not given to us in the original paper is borne out by the query made by Dr Percival of the Tatas at the end of the discussion as to who was the first to find fairly large quantities of vanadium in Indian ilmenite-magnetite. Dr Percival asked who was the person who was "hiding his light under the bushel".

This finally elicited the answer from Dr Dey that a paper on the subject by N. Ray had appeared in the *Proceedings* of Indian Science Congress, 1932.

It was long afterwards that Dr Dunn detected vanadium and in the microchemical test used by him he says he used "aniline dye" by which he apparently means aniline which is, of course, quite different from aniline dye."

Dr Dunn and Dr Dey consider the vanadium-bearing magnetite to be a new mineral. There is no convincing evidence in their paper for this view. Mr N. N. Chatterjee's comments on this subject are very cogent and they have not been at all satisfactorily answered. Ilmenite is now universally accepted as a solid solution of FeO, TiO_2 and Fe_2O_3. Isometric magnetites containing as high as 16% TiO_2 were observed by Cordier. Pope (*Trans. Amer. Inst. Mining Eng. 1899*) observed that magnetite occurring in the gabbro differs from others in being titaniferrous and in containing small amounts of V (from 0.23 up to 0·63% V_2O_5). The so-called titanomagnetite is a mechanical mixture of ilmenite and magnetite. Ilmenite and magnetite can form solid solution within a limited range. The micrographic study of Dr Dunn shows only that vanadium is not uniformly distributed in the body of the mineral. From the high-power microscopic study alone, the possibility of the mineral being an eutectic mixture of ilmenite and magnetite is not excluded. For this reason to treat the vanadiferrous magnetite as a new mineral and to call it "coulsonite" is, to say the least, premature. We ourselves did not call it a new mineral and in our opinion it should be provisionally called "vanado-magnetite" until more convincing characterization of it as a new mineral is forthcoming. This would be more scientific in the present state of our knowledge.

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23. 7. 37

Obituary

DR ALFRED ADLER

It is with a deep sense of sorrow that we place on record the sudden and unexpected demise of the distinguished psychologist, Dr Alfred Adler, which event took place at Aberdeen on May 28, 1937. By his death the psychological world has lost one of its active and enthusiastic workers.

Dr Alfred Adler.

Dr Adler was born at Vienna on February 7, 1870. He qualified himself as a physician. When he began practice, he was drawn towards the new method of treatment of neurosis and became a follower of Prof. Sigmund Freud, the eminent psychoanalyst of Vienna. He was, however, not wholly satisfied with Freud's methods. Endowed with a keen analytic mind, he soon diverged from his master's method and founded a separate school of psychology known as 'Individual Psychology'.

Dr Adler made valuable and voluminous contributions to psychology. In 1907, he published his *Studie ueber Minderwertigkeit von Organen*. In 1912, he published his work, *The Neurotic Constitution'* in which he laid down that the organic defect was the *raison d'etre* of the sense of inferiority which gave rise to 'masculine protest' and this in turn produced the neurotic constitution. Therefore the neurotic constitution could only be understood by unearthing the effort that the individual unconsciously makes to compensate for his organic defect. In 1927, he published his principal work, *Praxis und Theorie der Individualpsychologie* (Practice and Theory of Individual Psychology). In 1928, at the Wittenberg Symposium, he discussed 'Feelings and Emotions from the Standpoint of Individual Psychology'. He suggested that the feeling of inferiority, known throughtout the world as the Inferiority Complex', was the most important factor in an individual's mental constitution. This feeling and the social feeling are connected with and belong to the life plan with which both must be in harmony. "If we judge a feeling separated from other expressions and the style of life, we recognize only the physiological factors. For a psychological understanding we must know the goal towards which the feelings run."

Dr Adler was the Professor of Medical Psychology, Long Island College of Medicine. He was an Honorary Member of the Leningrad Scientific Medical Society. He was also the editor of *Internationale Zeitschrift fuer Individualpsychologie.* He was an erudite scholar and had a genuine enthusiasm for teaching. Just before his death he was called upon to deliver a course of lectures in different parts of Great Britain and America. It was arranged by the Alfred Adler Lecture and Vacation Course 1937 Committee of which Mrs Basil Hoare was the chairman and Sir Alfred Beit, Bart., M.P., the vice-chairman. We print below the programme which gives an idea of the value and popularity that are attached to his theory.

24th May-28th May	—	Course of 5 lectures on Psychopathology at the University of Aberdeen.
1st June	—	Public Lecture at Rowntress, York.
2nd June	—	Address to Diocesan Clergy at York.
3rd June	—	Public Lecture at Municipal Training College, Hull.
4th June-9th June	—	Lectures at Manchester.
10th June-16th June	—	Lectures in London for various societies
17th June	—	Public Lecture in London on "Social Interest: A Challenge to Mankind.".
51st June 2nd July	—	Lecture Course at Edinburgh
6th July-17th July	—	Vacation Course (14 lectures) at the University Hall, Liverpool.
17th July-31st July	—	Vacation Course at Exeter.
2nd August	—	Lecture: City of London Vacation Course in Education
4th August		Prof. Adler sails for New York.
15th August	—	Commencement of Vacation Course at Berkeley, California, U. S. A.

But the framer of the programme did not know that he was not destined to complete the task which he had so gladly accepted. On May 28, 1937, in the midst of his activities, death snatched him away.

Anathnath Datta.

DR SHYAMADAS MUKHOPADHYAYA

By the death of Shyamadas Mukhopadhyaya the world of science has lost one of its outstanding personalities. To Bengal in particular the loss is irreparable, since he was the pioneer of mathematical studies in modern Bengal.

Born at Haripal in Hooghly District on the 22nd June 1866, he graduated from the Hooghly College and took his M.A. degree from the Presidency College, Calcutta. He was the first PH.D. in Mathematics of the Calcutta University.

He started his career as a professor of mathematics at the Bangabasi College, from where he went to the Bethune College and then to the Presidency College. Finally when the late Sir Ashutosh Mukherjee built up the mathematics department of the Calcutta University, he was called upon to organize it, and was till retirement the professor of pure mathematics in the University of Calcutta.

During his long career, extending over more than forty years, it was his foremost consideration to inculcate among his students, by teaching and example, the love of science, especially of pure mathematics. A large measure of the credit for the development of mathematical studies in modern Bengal goes to him.

Dr Shyamadas Mukhopadhyaya.

His pioneering work on the geometry of convex curves has since raised him to international fame, but his earliest paper on the subject passed unnoticed because his ideas were in advance of the times. He was interested in the subject before others had seriously taken it up.

It would be difficult in a brief compass to give an adequate idea of his mathematical works, but I must attempt the task, for without it any account of his life would be hopelessly incomplete.

OBITUARY

In the series of papers relating to the geometry of convex curves (1 to 11)* a leading idea runs through his work, that every differential property arises from some geometrical property actually holding in the finite domain. Thus a cyclic point on a curve is defined as a point, in every arbitrary neighbourhood of which we can actually find four real distinct points lying on a circle. His proof of the now famous theorem that every oval has at least four cyclic points (2) consists in showing that on every oval there are at least four points such that by suitably varying a circle intersecting the oval in at least four points, four of the intersections can be brought in the neighbourhood of one of these points. A similar proof is given for the theorem on the minimum number of sextactic points on the oval (2). These theorems were later rediscovered in Europe, and have received various proofs at the hands of eminent mathematicians(*a* to *d*), but Mukhopadhyaya's proofs taken in the extended and rigorized form given later (8) go to the root of the matter, and at every step bring out the inner reason why particular results should hold. The demonstration of Transeen's theorem by the use of the idea of partial curvature (1), the various elegant properties on non-cyclic and non-sextactic arcs (2), the properties connecting cyclic points and normals (3), and especially the highly general results on admissible curves of index n (8), all testify to the power of Mukhopadhyaya's mathematical ideas.

In this connection must also be mentioned the papers wherein convex curves not possessing a unique circle of curvature or an osculating conic, at some or all points, are studied (5, 9). His novel and powerful technique, apart from his immediate students like the present author (*e*), is now being seriously taken up in Europe (*f*,*g*) and it is the author's belief that a vast number of highly important results not readily attainable in any other way remain to be discovered through the use of his concepts and methods. Especially important is the extension of his ideas to the geometry of convex surfaces. Little is known of the "im grössen" properties of these surfaces, in relation to the system of spheres and the system of quadrics. Only certain tentative suggestions have been advanced by Professor Blaschke. I gathered in conversations with Mukhopadhyaya, that it was his intention to make this extension himself, and his paper on 'Cyclic curves on Ellipsoids (12) was intended to be a feeler in this direction. The cruel hand of death has snatched him away from us, and it behoves those who have drawn inspiration from his work to carry it forward.

Another important series of papers due to Mukhopadhyaya treat of the differential geometry of curves. From his earlier studies on the differential geometry of curves, especially with reference to osculating conics (13, 14 and 15), he arrived at the idea of "Parametric Coefficients." It first received explicit application in his paper (16) 'Intrinsic Parameters in the Differential Geometry of Curves in N-space' for which he was awarded the Griffith Memorial Prize for the year 1910. A series of six powerful papers followed (17 to 22), in which the properties of Parametric coefficients were systematically developed, with applications to theory of curves of multiple-curvature in hyper-space. It will be interesting to note that many of the coefficients developed by him occur naturally in affine and other geometries, and thus possess a higher degree of invariance than postulated by him. The precise connection of his theories with these geometries however remains to be worked out. His methods and ideas also await extension to the geometry of surfaces (hyper-surfaces) of two or more dimensions immersed in a space of n-dimensions.

Mukhopadhyaya was an elegant synthetic geometer, and this gift found a powerful expression in his works on non-Euclidean geometry. Specially important was the discovery of the five right-angled pentagon (24) associated with the Engel-Lobatschewsky set of 5 right-angled triangles, and 5 tri-rectangular quadrilaterals. This figure completes the system of associated figures, and gives the physical basis of the Engel-Napier rules of hyperbolic Trigonometry. His other researches in non-Euclidean geometry were concerned with the

* The numbers in the brackets refer to the bibliography at the end of this sketch.

extension of the ideas of concurrence and collinearity (23, 25, 26). Certain notes of his on a device for visualizing four-dimensional figures are also highly interesting (28, 29, 30).

But Mukhopadhyaya was great not only as a researcher. As a professor he was highly appreciated by his students, for he always went to the core of things, and saw to it that his students should have a clear and firm grasp of the essentials. He was a man of extremely simple habits, and was full of the milk of human kindness. In his earlier years he was an all-round sportsman, and had a place in his college eleven, in cricket and football. He was an expert amateur photographer, and was fond of shooting as a pleasure and exercise. Later on he took to rose culture as a hobby, and his rose garden at Mihijam is well known to every lover of roses.

After retirement in 1932, Mukhopadhyaya went to Europe, with the Ghose Travelling Fellowship, to study methods of education. He also took this opportunity to expound his new geometrical ideas to many eminent European mathematicians and he was called upon to lecture before many learned European societies. Returning to India after one year, he again settled down to work, and took up, as I have already mentioned, the differential geometry of surfaces, with a view to extending his technique and ideas to this field. In 1935 he lost his eldest daughter, and after this shock he gradually lost his health, and his illness took a serious turn from September last. He expired of heart failure on the 8th May 1937, leaving behind him his wife, two sons, a daughter and numerous friends and admirers to mourn his loss. It will be deeply felt by the scientific public of India, not only because he was one of the leading figures in the world of Indian science and was a member of various mathematical societies and the President of the Calcutta Mathematical Society, but also because a large number of leading Indian professors of mathematics, physics, and other scientific subjects, have been at some time or other his students, and have drawn inspiration from him.

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Needs of Indian Archaeology

In Science and Culture, January 1936, we drew attention to the deplorable state of official archaeology in India. Indeed a reversal of the present state of affairs is such a pressing need that we may go back to the subject once more. In our previous issues we often had occasion to emphasize our belief that a systematic exploration of selected sites in India is sure to bring to light many unsuspected phases of the pre-history and proto-history of India, and may ultimately result in the discovery of the missing links between *c.* 3000 B.C., the date of Mohenjo-daro and Harappa, and 300 B.C., the date of the Mauryan Empire. This period of Indian history is at present very imperfectly known from incidental references preserved in the Vedas, the Upanishads, and the Epics. But these references, being mostly orally transmitted or recorded much later than the actual happenings, are often vague, puzzling, and mutually contradictory. Yet this period witnessed the development of such social institutions as are characteristic of India even at the present time, *viz.*, those of caste, *Asrams* (suitable occupation of man at different epochs of life and of the ascetic ideal); of the political institutions of kingship and Government; of such characteristic Hindu philosophical doctrines and concepts as transmigration of soul, the theory of *Karma*, of *Maya* (Illusion), and *Mukti* (Emancipation), theory of the *Brahman* (the Universal Soul), and the *Atman* (the Individual Soul). One would naturally like to know what was the succession of events which led the Indian savants to devise systems for ethnical control of mankind which was so radically different from the Semitic theories of creation, of the Original Sin of man, the doctrine of the divinely appointed Saviour or Prophet, and of the Day of Last Judgment. One would naturally like to know why the Indian mind, having very early shown great originality and great enterprise in mechanical inventions (witness, for example, the early invention of potter's wheel, of cotton weaving, of sugar making, domestication of wild animals and the early progress made in metallurgy and architecture) later became rigid and stereotyped and showed a tendency of remaining slave to traditions. Only material remains of the period between 3000 B.C. and 300 B.C., when brought to light, properly examined and analysed, can give us right answers to this question.

The question arises whether any material remains of this period do exist. The labours of the Archaeological Survey of India, prior to 1925, were largely directed to the excavation of sites like Rajgir, Sarnath, Kasia, Sravasti, etc., connected with incidents in Buddha's life; sites like Taxila, Peshawar, where Indian Civilization was admittedly influenced by Greek contact; or of sites like Nalanda which was of post-Buddhistic growth. This attitude was largely due to the false belief that Indian Civiliza-

tion was mainly the child of Greek Civilization. The discovery of Mohenjo-daro, once for all, laid the Greek ghost under earth.

Now we know that there is no lack of important sites that can throw light on this period, and one of the most urgent needs of Indian archaeology at the present moment is the mapping of pre-historic sites. The work done by Mr N G. Majumdar in Sind, by Sir Aurel Stein in Baluchistan and Central Asia and Eastern Iran is only a fraction of what remains yet to be done. In Sind itself, which explorations have revealed to have been the home of more than one pre-historic culture, large tracts of lands lay beyond the purview of Mr Majumdar's survey, and it is a matter of utmost regret that the work so well begun and so rich in its results, in spite of its limitations, should have been callously left incomplete on the plea of inadequate funds. It can be legitimately hoped that Sind will throw much additional light on the ever-increasing mass of evidence relating to the intimate connection between India and Iraq and other countries in ancient times. It should not be supposed, however, that with the survey of Sind the task will be complete. Kathiawar yielded to Bruce Foot many Stone-Age artefacts, now housed in the Madras Museum. To know the racial and cultural affinities of the people who fashioned and used them, a more systematic search in this region is necessary. Kathiawar also contains Girnar, already famous as the site of the most famous of Asoke's edicts, which has been identified by Dr N. K. Bhattasali as the City of Dwaravati, described in the *Mahabharata* as the city of Krishna. Who knows that a future Schliemann may not, in future, turn out with his spade material remains of one of ancient India's most romantic names? The same remark applies to the Central Provinces, the Deccan and the Far South, for merely the reports of the occasional discoveries of megalithic dolmens and menbirs and of hieroglyphic marks on burial urns can no longer satisfy the inquisitive antiquarian. In the Punjab, Harappa itself is a sufficient proof of the existence of rich prehistoric sites in that province. But even Harappa has been only partially excavated. The work there in connection with the cemetery area which was started by Mr Vats remains unfinished. The chalcolithic finds as far east as Kolta Nihang in the Ambala district also show the necessity of a survey in the Sutlej valley. There can be no reasonable doubt that the chalcolithic culture had important stations in the intervening area as well. Particularly noteworthy from the prehistoric point of view is the Kurukshetra region, the centre of later Vedic culture and the reputed site of the Bharat Battle. As Mr R. P. Chanda pointed out in the *Modern Review*, there is Vedic evidence to show that here the Aryans first came into contact with the pre-Aryan, indigenous population of India. Rajputana again remains untouched; we must not forget that its climatic conditions like that of Sind might have been more congenial in pre-historic times than it is now, and from time to time, reports of sand-buried cities in Rajputana appear in the press. The exploratory survey must be extended to the rich plains of the United Provinces, in the heart of which, in the districts of Cawnpore and Etwah, a large number of copper implements were discovered. The United Provinces contain the famous site of Hastinapur, capital of the Kurus, celebrated in the Vedas, the Epics and in Buddhistic religious scriptures. It is represented by a series of mounds in a village called Hatthanapur in the Meerut district. It contains the remains of Ayodhya, capital of the Ikshvakus who figure in the Epics as well in Jain and Buddhistic literatures as one of the leading ruling dynasties of India before the rise of the Mauryan Empire. It also contains Kausambi, now represented by the village Kosam in the Allahabad district, which according to Puranic tradition became a very important political centre soon after the Mahabharata War (*c.* 1200 B.C.); it is said that the descendants of the Pandavas moved there after the erosion of Hastinapur by the Ganges and ruled till about 150 B.C. The mounds which extend over a vast area may reveal remarkable pre-historic antiquities in its lower levels. Near Allahabad, there are large mounds at Bhita where partial excavations were carried out by the Archaeological Department some thirty years ago, and antiquities were obtained which, according to Marshall, carry us back to 1200 B.C. But of the vast mounds, only a small fraction has so far been explored. Still

farther east, at a site near Buxar, Dr A. Banerji-Sastri unearthed from a depth of 50 ft. terracotta figures of men and women which reveal Cretan similarities. All these sites when properly excavated will throw light on the most interesting period of Indian history.

Need for Foreign Co-operation

It is well known that progress of archaeological knowledge owes a great deal to private enterprise, and the response which such pioneering work is able to evoke in the minds of the philanthropically disposed rich men. The best example of private enterprise is afforded by the story of H. Schliemann who, fired by a lively imagination, set out to discover Troy and Mycinae and succeeded in revealing to an astonished world that these cities were not creations of poetic fancy, but had actually existed. These discoveries proved that stories preserved in the old classics were not mere legends, but were based on remembrances of actual occurrences. Similarly the archaeologist's spade in Egypt, Syria, Palestine, and Iraq has proved that many stories recorded in the Bible were based on actual occurrences, though the discoveries have shown that the real story was richer, more variegated, and more instructive.

The financial support from private parties (like the University of Pennsylvania who in co-operation with the British Museum provided funds for excavation of Ur of the Chaldees under Sir L. Wooley), which has made excavations in the Near East possible, is largely due to the appeal which the stories in the Bible have for the Western mind. The Indian traditions, as preserved in the Vedas, the Epics, and the Buddhist and Jaina Scriptures have not been able to make that appeal either to the enthusiastic pioneer in the West, or to the millionaire with a surplus to dispose of. True, India produced a Bhagwanlal Indraji, and and was able to attract a James Prinsep to solve her epigraphical puzzles. But these early efforts and discoveries were largely negatived by the growing belief that prior to the Greek contact in 320 B.C., India had not much of a material civilization to boast of. Now, as mentioned before, since the Greek ghost has permanently been buried under earth, more respect should be paid to native Indian traditions which picture the growth of Indian Civilization as a continuous, indigenous process going back to several millennia before Christ.

Early Indian thought gave to the world the first great world-religion -that of Buddhism. It was the first human attempt to bring all humanity under a broad code of universal ethical standard. Nothing like this was known in the world before and probably it was contact with Buddhism which converted the narrow tribal religion of the Jews to the universal religion of Christ, modified however, in its later developments by the Roman concept of using Christianity for worldwide political organization. It is debatable in the light of past history whether the Christian doctrine of Original Sin of mankind and of the Day of Judgment or the Buddhistic doctrine of Karma and Nirvana provide a better basis for ethical standards, or in future some basis like the materialistic conceptions of life may be found better for the ethical control of mankind. We know the story of the growth and decline of Buddhism, but we have the vaguest ideas about circumstances leading to its foundation. Will not the European archaeological parties who have so long tried to dig out the origins of Christianity in the Near East try to extend their labours by trying to find out the origins of Buddhism, by archaeological excavations carried on the Indian soil? To R. B. R. P. Chanda it was left to point out that the Mohenjo-daro figures prove that Jainism is not a heretical child of Brahmanism, but was in fact much older than the latter and is probably of autochthonous growth. The excavations of the sites mentioned will probably throw light as to what events led ancient Indians to favour a philosophy of life marked with extreme form of abstinence, asceticism, weariness of the pleasures of the world, and evolution of ethical standards based on lives of great men rather than an all-powerful Creator?

Problems of River Physics and How They are Solved

N. K. Bose

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In modern times, knowledge of science is being applied to almost all forms of human activity. River engineering has formed no exception to the rule. Even the ancients found from experience the necessity of controlling and interfering with the free flow of rivers. They had very often to throw bridges over rivers, divert river water, by means of canals, for irrigation, and erect storage basins, and they built embankments to keep out floods. They of course stood helpless before a great and spectacular castastrophe caused by a river, such as a great destructive flood, or erosion of banks causing destruction of prosperous cities and villages, and ascribed such phenomena to acts of God. They had probably no idea of the slower changes effected by rivers, especially in low lying deltaic regions, like changing the level of the country, formation of swamps, and marshes, giving rise to malaria and other epidemics. But even from their narrow range of activities, they obtained considerable knowledge of the science of hydraulics which formed the basis of the greater development in our knowledge of this science in recent years.

The interference with rivers has increased in recent times, the old problems are still present but new ones have been added. The introduction of steam locomotion has necessitated the construction of large number of bridges of entirely new design over rivers. It has been found that some of the rivers, if properly harnessed, can supply electrical power which is all-important for development of industries and other human needs. It has further been found that in spite of the railway and the automobile, rivers retain their importance for cheap and convenient transportation of goods. The proper execution of all the engineering problems connected with rivers requires a sound grasp of principles of river physics.

Very few people, when they see a mighty river flowing in its majestic course or hear of a devastating flood spreading ruin and misery over a countryside, think that there is a "physics" of river flow; very seldom can they imagine that such ruthless manifestation of nature can at all follow any laws of science. But instances are not unknown when slight but persistent obstruction to the course of a mighty river has diverted it from its destructive path when the apparently harmless and insignificant cut in the dead or almost dead arm of a river has sent it miles away from its previous course. These shew that even such apparently uncontrollable phenomena of nature follow the laws of cause and effect. It has been found that the laws of river physics can be as effectively studied in a laboratory as those of stellar physics are now being studied in a physicist's laboratory. I shall now try to explain how this is done.

How to Construct a River Model

Suppose the problem that confronts a river engineer is how and where to throw a bridge across such a mighty river as the Ganges. It is well known that the highest flood discharge of the Ganges before it joins the Brahmaputra is about 2 million cubic feet of water per second. The engineer finds from his level survey and from consideration of other economic and commercial factors that the river must be bridged between a certain stretch of, say, about 20 miles. He refers the problem to a river physicist

whom he supplies with all the facts and figures of the case, tells him what are the annual discharge curves of the river for that stretch over as long a period as available, shews him what has been the course of the river for the last 20 or 30 years and gives him similar other information. The physicist now starts to build a model of the stretch of the river across which the bridge is to be thrown. He knows that he has got accommodation in his laboratory to put in a model, say, 120 feet long and 60 feet wide. The stretch of the river that he has to model is 20 miles or 105, 600 ft. so that he chooses a horizontal scale

$$05, 6(\qquad 1000 \text{ (say)},$$

so that the horizontal distances in the river are all reduced in the ratio of 1/1000 in his model.

Now, how will he reduce the vertical dimensions of the river, such as the depth? The depth of water in such rivers as the Ganges very often reaches such a high value as 75 or 100 feet. But with the scale ratio of 1/1000 on the vertical plane a depth of water scarcely $75/1000 \times 12$ inches (say 1 inch) will be obtained in the model. This small depth will have two disadvantages :

(*a*) Reynold's Number (explained below) of the model river-flow will be very small so that the flow will no longer be in the turbulent region as in the actual river.

(*b*) Velocity of water in the model will be so slow that no silt in the bed of the model river will move and there will be no change in the river course.

I must now explain the two conceptions which have been introduced above. One is the connection between turbulence and Reynold's Number, and the other is the similarity of silt-movement in the model and the prototype.

Reynold's Number and Turbulence

Prof. Osborne Reynold while doing experiments on the flow of water in pipes found that when coloured dyes are introduced in the fluid distinct streamlines are formed throughout the whole length of the pipe but as the velocity of flow is increased these streamlines loose distinctness and suddenly become diffused at a certain stage of the flow. This indicates that the stream-line or laminar flow of water in the pipe gives place to turbulent or irregular pattern of flow at this point. This, he found, takes place at a certain value of a number which has since then become well known as the Reynold's Number

$$R_e \qquad \frac{vd}{\gamma}$$

where d is the diameter of the pipe, v the average velocity of flow in the pipe and γ Kinematic viscosity μ/ϱ viscosity/density. The critical value of R_e for pipe is generally taken as 2100 whereas for open channel it is about 525. The absolute magnitude of this number is not fixed ; it depends on the condition at entry to the pipe or channel. Whatever may be the absolute magnitude of this critical number it marks the transformation from one stage of flow to another, from the stream-line stage in which the liquid flow is laminar to the turbulent stage in which the flow is irregular. The laws of fluid movement in these two stages are totally different so that care must be taken not to make the model scales so small as to reduce the fluid movement to a laminar stage whereas in the actual river the motion is certainly very much turbulent. From experiments of Prandtl and NiKuradse it is known that even in the turbulent region there are grades of turbulence so that the scale effect, as the effect is technically known, does not altogether vanish till a high value of the Reynold's Number is attained. Experiments have shown that it is of the order R_e - 100,000.

Silt-Movement in Model and Prototype

The other conception introduced was the similarity of silt-movement in the model and the prototype. It is well known that there is considerable silt-movement in rivers at all stages, specially in rising and falling stages. The model must be able to reproduce this. This is achieved in various ways.

If the physicist follows some of the German or American practice he will proceed in the following

way. He will obtain a large sample of bed-load material from the river at the locality in question where the water surface slope may be 0.0001 (say). This sample will be placed in the flume to a depth of a few inches after which the flume is tilted to a slope of 20 × .0001 or 0.002. Then he will run water over the bed material, keeping the water surface slope equal to the bed slope and will increase the depth until movement occurs. Suppose that the general movement occurs at a depth of 0.5 ft. This indicates that the critical tractive force for this silt is according to du Boy's Law

Tractive force = $W.D.s$

$= 62.5 \times .50 \times .002$ lb./sq. ft

$= 0.0625$ lb./sq. ft,

where W = weight of water per cubic foot = 62.5 lb. D = depth of water = .5 ft, and s = slope = .002.

He now finds that if he does not give the model a vertical scale different from the horizontal, he shall have to give 10 ft depth of water in his model which is not practicable. So that he distorts the model 10 times, that is, he makes the vertical scale 1/100 and obtains with 1 ft depth of water in his model the same tractive force as is required to move this silt.

If he finds that he cannot have enough silt of the same size distribution and tractive force as the sample from the bed of the river he has to use any other silt locally available; first of all he finds its critical tractive force and gives the model appropriate distortion so that suitable depth of water is required to move this silt.

It is also desirable to know at what stage in the flood of the river general silt movement takes place so that it can also be simulated in the model. But this is not always possible.

Fixing of Scale Ratios

There is another school of river physicists who, instead of using du Boy's Law of tractive force, assume the various velocity formulae, empirically known as Manning's, Kutter's, Winkel's or Lacey's, and get the required scale distortion. If d be the vertical scale ratio and l the horizontal scale ratio in a model then the following relation can be obtained between them:—

$d = l^{.75}$ from Manning's Formula.

$l^{.65} > d > l^{0.75}$ from Kutter's Formula.

$d = l^{.725}$ from Winkel's Formula.

$d = f\,l^{.67}$ From Lacey's Formula.

All these relations give more or less the same scalar distortion which with a silt slightly finer or coarser than that of the river itself is found to give quite satisfactory result.

Thus the physicist fixes the vertical scale

$d = 100/1$ when

$l = 1000/1$.

Having thus fixed the scale ratio he proceeds to build the model. Generally the ground on which the model is to be built is made level to a certain depth on which a layer of clay and sand is laid to a depth of 6 inches which corresponds to 50 feet of the river. The model is then built on this so that the maximum depth of possible scour does not reach below this level. The top layer which for this particular model will be about 1 ft thick will be built in pure sand that had been selected previously from considerations of tractive force or scalar distortion. It has been found that slight admixture of clay, say 1 per cent, makes the model work better. At places where due to distortion the natural angle of repose of pure sand is exceeded a certain quantity of clay has to be mixed to make the banks stand up. This generally slightly vitiates the result which must be interpreted carefully.

The model is now ready. Now the physicist has to fix his discharge that will flow in the model and will correspond to a certain discharge in the river itself. Preliminary selection of this discharge scale is done on what is known as the Froud's Law which states that q, the discharge scale, is given by $q = ld^{3/2}$. This discharge is allowed to flow over the model and the gauges in the downstream end of the model are adjusted till they correspond to those in the river itself for the corresponding discharge. Having adjusted the tail gauges, attempts are then made to adjust the entrance gauges of the model by

varying the discharge. By the time the entrance gauges are set free by varying the discharge the tail gauges are disturbed and have to set right by manipulating the tail gates. This upsets the entrance gauges; so that by careful adjustment of the tail gates and varying the discharge all the gauges are set correct to a certain stage of the river and the ratio between the discharges in the river and the model for this stage gives the correct discharge scale.

The next scale to be fixed is the time scale. This is the most difficult of all the processes. This consists in finding the length of time for which a certain discharge in the model should run so that a certain transformation that has taken a certain number of years in the river itself to take place will be reproduced in the model. For tidal rivers which Gibson has mostly dealt with this can be easily managed. A wave on the water surface moves with a forward velocity $c = \sqrt{gH}$ due to the action of gravity if friction is neglected, so that if the depth scale is d a velocity in nature is $\sqrt{d}$ times the velocity in the model.

$$\frac{L}{l} = \frac{\text{Distance travelled by wave in prototype}}{\text{Distance travelled by wave in model}} = \frac{T\sqrt{gH}}{t\sqrt{gh}}$$

ie guide $\sqrt{\frac{H}{h}}$

Gibson found this scale to hold good for his tidal models. But our physicist has got a different kind of problem. The Ganges is a river that runs very low in most part of the year but rises in high flood for a very short period and does most of the harm in this period. The rapidity with which this stage changes is astonishing and will require very skilful manipulation of the model discharge to reproduce its most disastrous effects. Very careful analysis of the annual discharge curves of the river will be necessary before a certain period of years could be simulated in the model.

The Task of the River-Physicist

If our physicist succeeds in fixing this scale the first criterion that he shall have to satisfy is the following. Suppose he models the river to a survey of the stretch carried out in the year 1920, can he reproduce the conditions of the river in 1937 by allowing the model to flow for a certain length of time according to his model discharge curves? If he can do this even approximately, then he has chosen the fundamentals of his model correctly and he can now proceed to find the effect of constructing a bridge across the river. He has solved the most difficult part of his job, he has got his apparatus properly set up and functioning correctly. It will now require careful manipulation of the experiments and judicious and intelligent interpretation of the results to crown his efforts with success.

It will be seen that in building the model and before the physicist could actually run it for any definite purpose he had to encounter many uncertain factors that one even now very little understands; he had to make use of certain results that have not been accepted universally as yet. This state of affairs will only end when more and more experiments will be carried out with a view to clear our ideas about the various fundamentals of models.

Irrigation in India

We have received from the Central Board of Irrigation, Simla, publication No. 14, containing the annual report of the work of the Board in 1935-36. It is a big report of 125 foolscap pages and is divided into three parts and an appendix. Part I deals with the research officers' reports. We learn from the report that researches on irrigation are carried on at Lahore, Irrigation Research Laboratory at Poona, at Roorkee in the United Provinces, and at Karachi. From the report one gathers that no other province has thought it fit to organize a research laboratory for this important subject. The other two parts deal with the proceedings of the Research Committee and the Board Meetings, with an appendix containing the various notes submitted in writing by the officers of the Irrigation Department.

We are here primarily concerned with the first part which deals with the reports of the research officers. It is well known that the Punjab is ahead of all provinces in irrigation research. This is due to the development of the system of canals in that province where the research section was organized about two decades ago to deal with such problems as presented themselves in the canal area, as for example, the alkalinity of the soil, the *kunkur* formation in the soil, the determination of moisture and salt in the soils, water-logging, etc. A good number of research works are being conducted according to uptodate methods. In the Physics and Mathematics Sections work is being carried out on problems of subsoil flow, on silt investigations, and many other interesting practical problems. Particular mention should be made of the work done by Mr A. N. Khosla, Dr N. K. Bose, and Dr E. McKenzie Taylor on the design of weirs on permeable foundations. It is claimed that the problem of weir design in relation to flow of water through the foundation subsoil is now a solved problem. This achievement was the outcome of some nine years of sustained research in the field and over four years of that in the Punjab Research Institute. In respect of the latter, the profession express their gratitude to the illustrious band of scientists of the Institute, *viz.*, Dr N. K. Bose for working out the complete mathematics of weir design, to Dr V. I. Vaidhianathan for his researches with the electric model, to Mr H. L. Uppal for, those with the hydraulic model, and above all to Dr McKenzie Taylor, Director of Irrigation Research, who co-ordinated all these efforts with such excellent result. The work done on this subject in the Punjab Research Institute has been of a fundamental nature. It has been instrumental in furnishing the final solution.

In the Hydraulic Section investigations were carried out on the uplift pressures by the electrical method and on the models in the plume. "These investigations have been carried out largely with the object of developing suitable forms of protection downstream. The work studied during the year are as follows:—

(*a*) Panjnad Weir, (*b*) Merala Weir, (*c*) the Fall on the Main Line Lower, Upper Chenab Canal, (*d*) The Rapid on the March Chiniot Drain, (*e*) The Anderson Weir."

Investigations were also carried out on land reclamation and on deficiency of plant food in the reclaimed lands. A perusal of the work done by the Lahore Irrigation Research Institute proves completely the point of view advocated in this Journal that irrigation research should not be left to engineers alone but should be carried on by a competent staff consisting of soil chemists, physicists, mathematicians, and engineers.

The main work done at the Irrigation Research Division at Poona was on experiments with the models of the Ganges River and the Hardinge Bridge

on the Eastern Bengal Railway. The Hardinge Bridge spanning the River Ganges near Paksey on the Eastern Bengal Railway was constructed between 1910-1915. In order to maintain the course of the river through the bridge, guide and protection banks were constructed, *viz.*, the Right and Left Guide Banks at the bridge, a protection bank on the left bank of the river at Sara 3½ miles upstream, and another on the right bank at Raita, 12 miles upstream of the bridge.

In 1915-18, the course of the river near the bridge was along the left bank. Since then the river has changed its course and at present the main current flows along the right bank at the bridge. In 1931, the river started to make an embayment above the Right Guide Bank. To check this and to remove the danger of the river returning to the 1868 channel, and outflanking the bridge, a guide bank was constructed at Damukdia. In September 1935 after floods, when the discharge had reached 1.7 million cusecs, the Right Guide Bank was severely attacked and breached. Temporary bunds were hastily erected and disaster averted. During the following cold weather season, two protection banks were built behind the breach, known as the Mote and the Back Water Bund. In 1934-35 the breach was filled and the guide bank restored with thick stone carpeting.

At the request of the Railway Board experiments were carried out at the Hydrodynamic Research Station at Khadakvasla to investigate the causes of the breach and to show how effectively to remove the danger of further attacks.

Ten series of experiments were carried out in a model which included 25 miles of the river, the scale being such that one mile was represented by about ten feet. Of these, series X which showed the beneficial effects of reshaping the nose of the Sara Protection Bank by removing the pitching stones and allowing the river to erode into the nose, thus itself doing the reshaping, was considered the best solution, "being cheapest and yet sufficiently effective" and was recommended. These experiments indicate the following general results of the construction of the Guide Banks, *viz.*,

(1) that water tends to adhere to a guide bank and leaves it with reluctance ; and

(2) that guide bank pulls the river around its upstream nose; but there is a limit to the embayment caused thereby.

There are many questions of fundemental character which have arisen in connection with this model and the experiments are still in progress.

The Ganges is the main flood carrier in Bengal, and for the interest of the rural population it is necessary that the water carried by her should be equitably distributed over the different regions. As has been pointed out by Dr N. K. Bose and Mr S. C. Majumder in SCIENCE AND CULTURE this is at present not the case. Most of the water passes through channels in Eastern Bengal causing widespread erosion (destruction of villages and agricultural land) while Central Bengal is being starved and has become a country of dead rivers and malaria. Being deprived of the Ganges spill, which used to keep Central Bengal in health and plenty in the olden days, she is now progressively deteriorating in health and productivity of the soil and lands are gradually going out of cultivation. The principal spill channels which used to distribute the Ganges spill over the area, namely, Bhagirathi, Jalangi and Mathabhanga, are dying. As pointed out in SCIENCE AND CULTURE by Mr Majumder their offtakes, specially the offtake of the Mathabhanga, are however showing signs of improvement. If the money which was spent by the Government in devising extempore protection of the Hardinge Bridge were spent in improving these rivers and diverting a good portion of the Ganges flood through them, thereby restoring the Ganges spill in Central Bengal, which she so badly needs, not only a permanent solution would have been found for saving the bridge, but Central Bengal also would have returned to her old prosperity and health. Though the bridge seems to have been saved for the present at a prohibitive cost, it does not appear that we are still out of the wood. As pointed out above when the bridge was constructed the main current was along the left of Sara bank. Rivers in Deltaic

Bengal following a meandering course through very friable soil can hardly be considered as stable and we should not be surprised if after a few years we again find the Ganges near the bridge attacking the left bank. In fact it is understood that near about Lalpur on the left bank, a few miles above the bridge, considerable erosion has already taken place, and the Ganges has approached within a very short distance from the main railway line to Darjeeling. If the erosion continues, a situation quite as threatening as experienced recently when the south bank was being attacked is likely to arise. In fact the situation is likely to be even more serious. For once the main line at this point is breached and the Ganges flood finds access to the vast depression near about Chalan Bil, there is risk of the main river being diverted in this direction with serious consequences not only to the railway interest but also to the countryside. It therefore seems to us that even now our suggestion of diverting a good portion of the Ganges flood to Central Bengal as a permanent solution for the safety of the Hardinge Bridge is not too late. In fact this is a matter in which interests of the Bengal Government are identical with those of the E. B. Railway and we urge the former to take the initiative and press this view before the Imperial Government.

In addition to the history of the Sara bridge given above, we may add a little more information. The Sara bridge was constructed, at the insistence of the Bengal Chamber of Commerce, on a site which was condemned by the investigating engineer, Sir Francis Spring, who first drew the attention of the Government for investigating river problems in a properly organized river physics laboratory before any great engineering work was taken in hand. The Government did nothing of the kind, and they had to pay a penalty of 2-3 crores of rupees when some of the predictions of Spring came to be true. They have awakened now so much to the gravity of the situation that the Railway Board has referred the problem for a permanent solution to the Research Laboratory at Poona. There is no doubt that the staff will do their best to give an adequate solution of this problem, from the point of view of safeguarding the interest of the E. B. Railway, but the criticisms may be offered that the problem is the creation of the Government and if a wider and a larger view were taken, it should have been much to the interest of the country.

The Poona branch reports several experiments of local interest of irrigation for the use of baffles, and on the design of the baffles and the silt of the downstream pavement of the Sukkur Barrage.

Laboratory experiments were also carried out on reclamation of alkali lands.

In the United Provinces important research work is being carried out under Mr G. Lacey, Superintending Engineer, on fundamental hydrodynamical problems regarding the flow of water in open channels. The formulae which Mr Lacey has derived for taking into account the effect of viscosity on the flow of silt-laden water are considered to be of great fundamental importance.

In the U. P. the Sarda River which is a tributary of the more well-known Sarju has been utilized for generation of hydroelectric power. A barrage has been put across the river at Banbasa. The safety of this barrage has given rise to many practical problems which were attacked with the aid of model experiments.

In the Research Station at Karachi experiments were carried out about engineering problems in the canals with which the problem is served. Mr T. H. Curry, the Chief Engineer of the Irrigation Section in Bengal, spoke on the policy of irrigation in India with particular reference to future development and finance. He practically supports the view taken by SCIENCE AND CULTURE that *every province, at least region, should have her own irrigation research laboratories, and the problem of one province cannot be tackled in the research laboratories in another province by officers who are unacquainted with local problems.* The following quotation from his speech would be instructive:

> "The natural condition in the different provinces vary greatly. For example, the conditions in the provinces of Northern India are quite different from those in the provinces of the South and along the coast. Accordingly, it is difficult for an Irrigation Engineer, who has spent his service in one province, to enunciate a policy suitable for another part of this subcontinent."

Iron as Food

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SINCE the earliest times the proteins (derived from meat, fish, egg, milk, pulses, etc.), carbohydrates like starch (obtained from cereals and other sources) and sugar, and fats have been recognized as our principal food elements. Of course, the body needs in addition a small quantity of mineral salts of potassium, calcium, phosphorus, and iron for its physiological well-being. The importance of these minerals has been further revealed from the recent researches on nutrition and it is now being believed that deprivation of any of them generally leads to a pathological derangement, and thereby inhibits the formation among other things of blood, brain, bones, and tissues of the body. We have, however, obtained their supply from the normal food-stuffs for thousands of years before we knew the function or even the existence of these elements. Unfortunately, with the advent of modern civilization we are forced to take a too restricted diet and this again, being highly processed or refined, is so ill balanced that their deficiencies may develop at any time. So in adjusting the correct quantities of different food-elements for our daily dietaries their proportion should always be properly maintained and the supply be never left to chance.

Function of Iron

Amongst the mineral elements, iron differs in being essential to the life of many, probably all forms of protoplasm (Cushny: *Pharmacology and Therapeutics*). To us it stands in the closest possible relation to the fundamental processes of nutrition, being an important element both of the red pigment (haemoglobin) of blood and of the cytochromes so essential in controlling the vital activities within the cells. But the total amount of iron present in our body is small, only about 0.005 per cent of the body weight. This would come to about 3 to 4 gms (*i. e.*, weight of about 6 to 8 ordinary writing nibs) in the case of a normal adult. Of this amount, two thirds are present in the haemoglobin of the blood and the remaining portion is distributed amongst the liver, kidney, spleen, lungs, pancreas, muscle and hair of the body. The percentage of the mineral in haemoglobin again is only about 0·335; but it is this minute amount that enables the blood to absorb and carry oxygen to the different cells, and thereby helps in maintaining the metabolism of the various tissues. It may be pointed out that iron is also essential for the proper growth of plants. A slight deficiency would diminish greatly the yield of a crop and a greater one alters the colour of the leaves owing to defective chlorophyll formation. The wide distribution of iron indicates its fundamental importance in addition to its specialized functions.

Supply of Iron

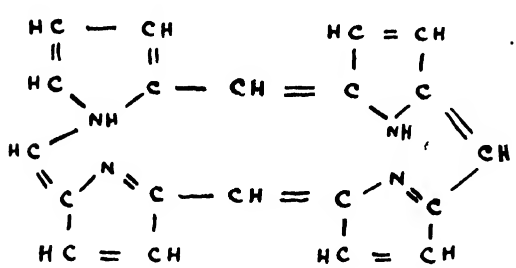
Apart from the natural endowment of iron which we receive at birth, all the iron required for the system must be obtained from our food and this again in sufficient quantity which would help the normal metabolism of the body and keep pace with our growth. Iron stored in the body is continuously being eliminated in faeces to a maximum of 20 mgs and a considerable amount (about 50 to 100 mgs) is being removed from the circulating blood along with the daily destruction of red blood corpuscles. But at the same time blood-forming organs are supplying an amount of iron that is required for the daily formation of haemoglobin of new red cells. This shows that the stock of the mineral must be replenished regularly to ensure the proper formation of haemoglobin. It must be remembered that if the blood lacks in haemoglobin (the oxygen carrier), oxygen, so vital for our system, cannot be brought to the tissues and the result would be general anoxemia.

IRON AS FOOD

The average iron intake of an adult man according to Rezni Koff and his collaborators (*J. Nutrition*, 7, 221, 1934) is only 10 to 20 mgs. Of this amount only 7 to 9 mgs might be absorbed in the system (Widdowson and McCance, *J. Hyg. Camb.*, *36*, 13, 1934); whereas, as pointed out above, the loss due to haemolysis of red cells alone comes to an average of 75 mgs of iron. Again, the total amount of iron present in our food would always vary much with the amount and nature of the diet. It is obvious, therefore, that its daily requirement would hardly be available from the food alone. The remaining portion of iron for its daily metabolism must then come either from the haemoglobin of the destroyed corpuscles, or from the liver, spleen or other tissues where iron is always being stored up for its subsequent utilization.

Assimilation of Iron

The question now naturally arises: How and in what form the iron is being absorbed and utilized by the system? Iron as present in our food is generally found to be existing in the form of simple soluble iron salts and compounds of iron hydroxide with proteins, and also as chromoproteins, *i.e.*, compounds of protein with a pigment of porphyron type (I). Haemoglobin belongs to this nature.



(I)

At one time it was the general belief that it is in this latter form that iron is absorbed and assimilated and from this haemoglobin is produced. But it is now being gradually recognized that for the absorption and assimilation of iron in the system the food iron will have to be changed largely, if not wholly, into simpler and ionized forms of iron. For this the food iron will first have to be converted by our digestive processes into more diffusible molecules. But to what extent this may happen we do not exactly know. On the basis of the above hypothesis, it is clear that iron of haemoglobin, haemin or any complex organic compounds which generally tend to resist the above process will not be available in the organism and accordingly, will escape absorption (Elvehjem, *J. Amer. Med. Assoc.*, *98*, 1046, 1932; *103*, 61, 1933). The value of any of our iron-containing food would then depend not only on the total iron contents present in it, but on the simpler or ionizable portion. The type of iron which is easily absorbed and utilized in regenerating the haemoglobin of the body is now being termed 'available iron' and this is found to correspond closely with the form of iron that can be estimated by Hill's dipyridyl method. Feeding experiments on animals clearly indicate that the haemoglobin formation is directly proportional to the amount of available iron as determined by the above chemical method. This, in other words, would mean that a substance rich in available iron is a more valuable food so far as its power for regenerating haemoglobin is concerned. In this connection the following table from Elvehjem's work, showing the percentages of available iron in some biological materials, would be of considerable interest.

TABLE

Substances	Total Iron per gm dry material : mg	Available Iron per gm dry material : mg	Per cent available
Peas (canned)	0·122	0·111	90
Almond	0 042	0·037	88
Soy-beans (non-roasted)	0·091	0·073	80
Peas (fresh)	0·188	0·085	72
Beef liver (dry)	0·261	0·183	70
Pork liver (dry)	0·652	0·434	66
Bananas	0·014	0·0086	61
Soy-beans (roasted)	0·10	0·06	60
Apricots	0·043	0·021	50
Oysters (dry)	0·320	0·080	25
Parsley (dried)	0·340	0·069	23
Spinach (fresh)	0·352	0·067	19

From the above table it is evident that a larger percentage of iron in any food material would not necessarily supply a greater amount of available iron. This would most probably mainly depend on the amount of inorganic iron present. Thus, the iron of egg yolk, which is present not, as formerly supposed, in organic combination but as an inorganic compound, is completely available for the system (R. Hill, *Proc. Roy. Soc.*, Series B, *107*, 205, 1930) It now seems advisable to extend a similar investigation to some of the wellknown iron-containing food-stuffs that are available in our country. Of course, work in this direction is already in progress in this Laboratory.

Its Importance to Women and Children

Although our ordinary food supply with common salt added to it should carry an abundance of the essential mineral elements to meet the necessary nutritive requirements, the usual and average dietary is often found to be deficient at least in a mineral like iron. Its supply to pregnant women and nursing mothers is of additional importance as their food should always be rich not only in proteins, vitamins but also in iron and this latter again in such excess that besides supplying their personal requirements an amount must be left behind for utilization by the growing foetus in the former cases and for excretion with the milk during lactation period in the latter. But as anaemia is found to be present in a considerable percentage of Indian women the question naturally arises how the vital processes, especially those of reproduction, are being carried on with such a vitiated blood supply and consequently curtailed supply of oxygen to the tissues. They require something which would increase the number of red-blood cells and percentage of haemoglobin. To fill this want properly and effectively iron must be supplied in sufficient quantity that would insure and satisfy their need during the above period. Most probably it is for this want of iron in the system that during pregnancy many women in this country are found to chew and take some earthy materials which are obviously rich in iron oxide. Here another point may be raised and this is that besides iron certain other mineral elements like copper, manganese, and zinc are also required for nutrition. They have nothing to do with iron absorption but only function in the conversion of the absorbed iron into haemoglobin. It has even been noticed that administration of iron has resulted in its accumulation in the liver without any increase in the percentage of haemoglobin but a subsequent addition of copper has promoted the conversion of stored iron into haemoglobin. The importance of copper in the proper assimilation of iron is also evident from the recent observation of Smith and Otis (*J. Home Econ.*, *28*, 395, 1936) that all the iron of banana is fully utilized for haemoglobin formation if supplemented with sufficient copper. Once the formation of haemoglobin is ensured, then it is certain that it would stimulate the other cell-forming tissues such as the bone marrow to pour new cells into the circulating blood and thereby increase vigour and vitality of the body.

Again, if we consider nutrition during infancy and childhood, we would find that milk, the chief food during a considerable period of early growth, though rich in minerals, is deficient in certain blood-forming elements like iron, copper, and manganese. In this respect human milk is much better than cow's milk as it contains a much larger percentage of iron. However, the natural storage of this mineral element in the new-born counteracts the deficiency of iron in cow's milk. But this endowment varies with each infant and, for the reasons cited above, is liable to be exhausted very early in the nursing period. Necessarily they should be fed with type of foods which would supply the blood-forming elements to the best advantage. It may be further pointed out that as there is a close inter-dependence of the different minerals in their assimilation, the ratios of different mineral constituents of any diet to each other are of as much importance as the total amounts. Thus phosphorus and calcium are mutually dependent on each other ; so also are the latter and iron for utilization in the system. This is of special importance when the feeding of cow's milk is considered. Here heating causes the dissolved phosphorus and calcium salts of milk to form tricalcium phosphate which interferes with the assimilation of iron. It follows,

therefore, that the heated cow's milk would be inferior to raw milk in nutritional value and this would further depend upon the degree of heating. This view has been actually substantiated by Okado and Sono (*Jap. J. Exp. Med.*, *12*, 197, 1934). In human milk, however, the different mineral constituents are present in a well-balanced ratio and the consequence is that the infant derives more mineral constituents from human milk in spite of the fact that cow's milk contains a much larger percentage of mineral excepting iron. It is possible that this deficiency of iron in cow's milk was known to us from very early times as is indicated by the custom of boiling milk in an iron pot. This is all the more significant from the observation of Lucas and Henderson (*Can. Med. Assoc. J.*, *34*, 53, 1936) that the iron content of vegetables considerably increases on cooking them in heavy iron pots.

One of the most common systems in infant feeding is to admix milk with lime water. But this addition of lime water to infant's milk cannot be supported as it would tend to convert the soluble calcium present to insoluble calcium salts (as phosphates) and thereby would inhibit the assimilation of other mineral elements. Another practice is to add certain cereals to milk apparently to increase the food value of the infant dietary. But there are experimental evidences (Elvehjem, Hart and Sherman, *J. Pediatrics*, *4*, 65, 1934) to show that this does not induce normal haemoglobin formation. The above authors further state that the addition of a small amount of iron salt admixed with a trace of copper (as sulphate) gives a more rapid and prompt response in the above direction. In the light of these observations it is better to enrich the milk-cereal diet of the children either with foods rich in available iron, or simply with some assimilable iron pyrophosphate along with salt like soluble iron, copper, and manganese to insure optimum haemoglobin formation. This is more needed for an infant born with a reduced supply of iron, or for one whose supply has been depleted by illness or by some other cause. But the amount of iron, if ingested, must be small (about 5 to 6 mgs daily) so that it might not again interfere with the assimilation of calcium and phosphorus—the two other essential elements for the proper maintenance of health.

Its Value in Diseases

The administration of iron is found to be valuable in the treatment of anaemias, particularly of hypochromic type. It has a specific action in promoting the formation of haemoglobin content of blood after an attack of tuberculosis, syphilis, malaria or similar other acute diseases. In these cases also the iron salts which are easily soluble and readily yield ionizable iron are far more superior and reflective than any other form of iron. Amongst the ionizable iron salts ferrous salts are being preferred. Further, as ferrous chloride undergoes no change in the stomach and forms with albumin a soluble and non-irritating compound it should be the most suitable salt of iron for administration in the treatment of hypochromic anaemias. But the most active preparation of any iron salt is not necessarily the best so far as its medicinal use is concerned. For its use in any haematopoetic preparation certain other factors such as tolerability, palatability, stability, and lastly the price should also be considered. Another difficulty that arises with any such preparation is about the strength or concentration of the iron solution. This is, of course, mainly due to our imperfect knowledge of the therapeutic doses of iron. There are certain cases of hypochromic anaemias which would easily respond to smaller doses of iron such as 50 mgs per day, whereas there are other cases where iron must be given in such doses as would lead to the accumulation in the body of about 3 to 4 times the above amount. So a method is still to be found by which it would be possible to distinguish between the cases in which a small amount of iron is sufficient and those which demand a higher dose. This is of greater importance when a soluble inorganic iron preparation like ferrous chloride is to be prescribed. Any dissociable iron salt by precipitating the proteins behaves and acts as an irritant. On the contrary, the less dissociable salts like ferri et ammonii citras, ferri peptonate, etc., do not precipitate protein and as such are less irritant. But, as mentioned above, these iron preparations would seldom exert any therapeutic activity unless ingested

in heavy doses. The following table adapted from Witt (*Lancet*, 1936, *i*, 1) shows the relative value of some common iron preparations :-

Type	Daily dose in gms	Iron content in gm	Percentage of Utilization
Reduced Iron	1.5 to 6	1.2 to 5	0.5 to 2
Ferri et Ammonii Citras	4 to 8	0.8 to 1.6	1.5 to 3
Bland's Pill	3 to 4	0.3 to 0.4	6 to 8
Ferrous Chloride	0.25 to 0.5	0.1 to 0.2	12 to 25.

From this the utility of ferrous chloride can be easily judged.

A problem, which arises specially in connection with a commercial preparation, is how to obtain a stable ferrous iron solution as the ferrous salts are readily oxidized in solution by the dissolved oxygen according to the equation :

$$4\,FeCl_2 + O_2 + 2\,H_2O = 4\,Fe\,(OH)\,Cl_2.$$

From the equation it seems evident that the lowering of the solubility of oxygen might enable the iron to remain in ferrous condition. The presence of an acid too would retard the conversion of ferrous chloride to a ferric salt in which form the iron is generally found to be extremely irritating to the stomach. This acidity of any ferrous salt preparation, like sugar and alcohol, might further help in the absorption and retention of iron in the body (*e.g.*, Mettier and Minot., *Amer. J. Med. Sci.*, *181*, 25, 1931). But an extra amount of acid in an iron preparation again would cause tenderness in gums and blacken the teeth. In spite of all these drawbacks, the inorganic iron for its lower bulk and better action is gradually being favoured. Of course, if there be a reasonable assurance that iron of any inorganic preparation would remain in the ferrous state, it should not be at all irritating to the stomach, particularly if taken admixed with milk. Under these circumstances this simple iron salt would serve as a good tonic for those suffering from anaemias.

In conclusion, it may be mentioned that we are still considerably in the dark regarding the mechanism of assimilation and utilization of iron of vegetable as well as of animal origin, and there are many unexplained factors in the aetiology of anaemias. So an iron food should always be taken with diet rich in other important food elements like protein, vitamin, etc. It has been shown by Bethell (*J. Amer. Med. Assoc.*, *107*, 564, 1936) that in cases of anaemia in pregnancy simultaneous feeding of inorganic iron and protein of high biological value ensures a better result. Further J. Tweddell (*Canad. Med. Assoc. J.*, *34*, 661, 1936) observed that admixing of a soluble inorganic iron preparation with vitamin B_1 and B_2 concentrates promotes an increase of haemoglobin formation in anaemic rats.

Ancient Indian Medicine and Modern Therapeutic Research

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The Antiquity of Indian Medicine and its Scientific Background

THE history of the origin and evolution of Hindu medicine offers an interesting and stimulating field of study and affords one of the best examples of the cultural heritage of India. Some scholars consider India to be the birth-place of medicine and surgery. According to Dr Wise, the renowned Oriental scholar, "it is to the Hindus that we owe the first system of medicine." Whatever be the truth in these claims, there seems little doubt that the foundations of early Hindu medicine were laid long before the dawn of the Christian Era. In fact, if we take into account some of the very early available records, we can trace its origin to the remote past when history is hazy and unreliable. The earliest mention of the medicinal use of plants is to be found in the *Rigveda* written about 1,500 B. C. which is one of the oldest, if not the oldest, repository of human knowledge in existence. The only other book which is almost as old as the *Rigveda* is the Chinese medicinal classic, *Pen T'sao* written by Emperor Shen Nung about the period 2,760 B. C. A chronological table of some of the important medical publications before the Christian Era is given below to indicate the wealth of material present in the ancient Hindu medicine.

Ancient Books of Hindu Medicine*

(Before Christian Era)

Rigveda	4,500 B.C.—6,000 B.C.	(?)
Atharvaveda		
Ayurveda (The Science of Life)	1,000 B.C.—2,500 B.C.	(?)

(a) *Salya Tantra* Major Surgery.
(b) *Salakya Tantra*—Minor Surgery.
(c) *Kaya Chikitsa*-General Medicine.
(d) *Bhuta Vidya*-Deranged faculty of mind, Insanity, etc ;
(e) *Kumara Bhritya*-Pediatrics.
(f) *Agada Tantra* Toxicology.
(g) *Rasayana*-Chemistry.
(h) *Baji Karana*-Sex Psychology.

Charaka	1000 B.C.-800 B.C.	(?)
Susruta	800 B.C -700 B.C.	(?)
Bhaobhata, *Madharakara*, *Chakadatta*, *Srangadhara*, *Kanada*, *Sankarasen*, *Bangasena*	Between 500 B.C.-100 B.C.	(?)
Bhojaprabandha	50 B.C. or probably 100 A D.	(?)

* The dates given by the author in some cases, we are afraid, differ widely from, and are much earlier than, those generally accepted by scholars.—*Ed. Sc. & Cul.*

In the *Atharvaveda* which followed *Rigveda*, the use of drugs is more varied though the description of charms and amulets covers nearly 50% of its pages. It is in the *Ayurveda* that definite properties of drugs and their uses have been given in some detail. *Ayurveda*, in fact, is the very foundation stone of the ancient medical science of India. As will be seen from the table, it has got 8 distinct divisions. All the sections of this ancient treatise are well written and contain a masterly description of the science as it was known in that time. Particular mention may be made of the chapters on medicine, toxicology, pediatrics and sex psychology, which have been considered by competent scholars as containing some minute observations which have been fully borne out by modern science. *Charaka* (1,000-900 B.C.) and *Susruta* (800-700 B.C.) are the next two important and outstanding contributions of Hindu medicine and it will be worth while to consider them a little more in detail.

ANCIENT INDIAN MEDICINE AND MODERN THERAPEUTIC RESEARCH

The book of *Susruta* is divided into 6 sections: (*a*) Sutra sthana, (*b*) Nidana sthana, (*c*) Sarira sthana, (*d*) Chikitsa sthana, (*e*) Kalpa sthana, (*f*) Uttara sthana. Excepting the 5th section which deals fairly comprehensively with drugs, poisonings, and antidotes, *Susruta* may be considered as a purely surgical treatise. The author was essentially a surgeon and described surgery as "the first and the best of medical sciences, less liable than any other to the fallacy of conjecture and inferential practice, pure in itself, the worthy product of heaven". Susruta certainly knew the importance of anatomy as the basis of surgery. His description of 300 bones and 210 joints looks curious to the modern anatomist, yet it astounds one to see the carefulness of the descriptions of some minute structures of the body. Susruta's students were required to dissect the human body and to report on the position of the various organs with reference to the external surface of the body (surface anatomy). His knowledge of obstetrics in general is quite satisfactory. His description of the menstrual cycle, the state of the body during this period, and the cleanliness to be observed at this time seems quite modern. The diet he prescribes for a menstruating woman is a very calcium-rich diet and modern knowledge has shown that there is a good deal of calcium loss from the system during this period. The descriptions of the factors influencing conception, the stages of normal labour, and other details of a similar nature are not very different from modern ideas. The management of normal delivery and the use of forceps for the treatment of abnormal conditions are intelligently described.

Excellent prenatal and postnatal care was practised. Mukhopadhyay in his study of the surgical instruments of the Hindus has shown that no less than 127 surgical instruments are described by Susruta. Surgical operations were divided into many branches, *e. g.*, incision or cutting, scarification and inoculation, puncturing, probing, sounding, etc. All these operations were performed by the "yantras" or blunt instruments and "sastras" or sharp instruments. Susruta tells us that cutting instruments should be of "bright, handsome, polished metal, and sharp enough to divide a hair longitudinally". The operating room, according to him, should be clean and fumigated with disinfecting vapours before and after all operations. The technique described for lithotomy, caesarean section, rhinoplasty, skin grafting, cataract couching, amputations, setting of fractures, reduction of hernia, etc., is certainly extremely instructive to any student of modern surgery.

Let us now see what we find in the pages of *Charaka*, which deals mainly with medicine. The book is divided into eight sections more or less on the same principle as followed in *Susruta*. A survey of these chapters reveals a remarkable description of the materia medica as it was known to the ancient Hindus. Charaka classified drugs in the following manner:

Drug Classification (Charaka)

1. Vegetable	2. Mineral	3. Animal
Tuberous and Bulbous Roots	Chemicals	Organs
Bark of Roots	and	in
Bark of Large Trees	Metals	Dried form.
Trees Possessing Smell		
Leaves		
Flowers		
Fruits		
Seeds		
Acrid and Astringent Vegetables		
Milky Plants		
Gums and Resins		

It will be evident that the vegetable character of the materia medica is most pronounced and it includes about 2,000 vegetable remedies. Only a few mineral drugs and still fewer animal remedies are cited. The soil, the season, and the gathering time of individual drugs of the vegetable kingdom are mentioned. The methods of administration of drugs are fully described and bear a striking resemblance to those in use at the present time; even administration of medicaments by injections has not failed to attract attention. Children's diseases have their share of attention and preventive medicine—the 'keep-well' rather than the 'get-well' point of view—which is only a recent development of modern medicine, has been duly stressed. Natural and artificial feeding for the child is considered. The

proper foods to be eaten, the clothes to be worn in different climates, and the hour of sleep and rest are all mentioned. Dental hygiene and the utility of some sort of a brush to remove the food debris clinging between the teeth was fully appreciated. As pathology was entirely unknown, the diseases were studied from clinical symptoms only. The methods of palpation of the radial artery and interpretation of various changes and their significance in disease are described. Following *Charaka* and *Susruta*, a number of other valuable books on medicine and surgery were published. These are mostly of the nature of 'specialization books' and have dealt with particular sections in more detail according to the individual experiences of the authors. Thus *Bhagbhata* deals with anatomy and dissection of the human body and *Chakradatta* contains a special chapter on epidemics and their prevention. These books, however, may be generally considered as compilations from the two classical works—*Charaka* and *Susruta*.

It is not necessary to go into more details regarding the numerous evidences of the high standard of ancient Hindu medical culture. The examples cited will amply prove that the ancient medicine of India was not based on pure empiricism but was permeated with a scientific spirit, as evidenced by a desire, by observation and experiments, by induction and deduction, to probe the secrets of nature and to build thereon a rational system of medicine.

Hindu Medicine and its Foreign Contacts

From the time of *Charaka* and *Susruta* up to about 1,200 A.D., Hindu medicine had a very good progress and practically attained its highest development. Available evidences clearly indicate that the knowledge of the Hindu physicians in the domain of drug therapy and toxicology at this period was far in advance of that of others. Snake-bite remedies were definitely known. Even anaesthetics in some form or other were known as there is definite reference to an inhalation anaesthetic called 'Sammohini'. Towards the close of this period (about 1200 A.D.,) Ayurvedic medicine made its way far beyond the limits of India. The influence of Hindu medicine penetrated far and wide into Egypt, Greece, and Rome, and moulded Arabic medicine also. Charaka's fame travelled into Arabia. Avicenna, the renowned writer on Arabic medicine, quotes him as Scirak, and Rhazes, who was prior to Avicenna, calls him Scarak. One of the earliest of the Arabian authors, Serapion, mentions Charaka by name as Zarch. In the eighth or ninth century A.D., *Charaka* was translated and was well known in Arabia. Jacolliot remarked, "India, that immense and luminous centre in olden times, was in constant communication with all the people of Asia, and all the philosophers of antiquity went there to study the science of life". The early contacts of India and China are recorded in Buddhistic works. Moreover, China exported to India turmeric, camphor, cubebs, alum, arsenic, orpiment, glue, etc. From Bombay, there were imported Arabian frankincense, patchuck, rose maloes, etc. These contacts still continue, and they reflect centuries of trade and contact between the two countries. Accurate botanical identification of the vegetable drugs in India and China shows that there were materials from about 211 identical sources. There is also evidence to show that an external trade in Indian drugs existed between India and Rome many centuries ago. In the days of Pliny, this drug trade assumed such enormous proportions that he actually complained of the heavy drain of Roman gold to India in buying costly drugs and aromatic spices. There is reason to believe that many Greek philosophers like Paracelsus, Hippocrates, and Pythagoras actually visited the East and helped in the transmission of Hindu culture to their own countries.

Decay of Indian Medicine and the Rich Heritage of a Combined Materia Medica

After this period, however, the glories of Hindu medicine rapidly declined. During the invasion of India by the Greeks, Scythians, and Mohammedans succesively, a good deal of the existing Ayurvedic literature was mutilated or lost. Various branches of medicine passed into the hands of priests, and

drugs and herbs gave way to charms and amulets. The knowledge contained in *Ayurveda* and other similar books began to be considered inspired and incapable of improvement by the ingenuity of man. The study of surgery and the touching of the dead body were considered sinful and dirty work. The dissection of dead bodies being discontinued, advancement in anatomical and surgical knowledge naturally declined. The Buddhistic doctrine of *Ahimsa* added the last straw. With the advent of the Muslim conquerors, Arabic system of treatment (Unani-Tibbi system) became the State system of relief and the Hindu system was pushed to the background. Most of the original literatures and records were lost, but it was not altogether a curse. During the contact between the old Hindu medicine and the Arabian medicine, which by the way was already fairly well developed, there was a great deal of intermingling and each utilized the materia medica of the other. With the advent of Europeans the decline was still further marked. Whatever now exists is in a highly chaotic condition and is a conglomeration of the various foreign influences around the original core. Though the system is very greatly mutilated and is now beyond recognition from its original form, a rich store of combined materia medica is left behind. This is a veritable mine of knowledge and will undoubtedly repay careful study and critical analysis.

Debt of Modern Medicine to Ancient Materia Medica

The credit of directing the attention of the medical profession and the public at large to their ancient systems of medicine, particularly its materia medica, rests primarily with certain Western scholars interested in oriental studies. The more chemical side of it has been explored extensively by Sir P. C. Ray in his well-known *History of Hindu Chemistry.* There seems little doubt that out of the large number of drugs used by the Hindu physicians for centuries past and still in use, there are many that deserve the reputation they have earned as cures. It is true that empiricism and superstition are intimately mixed with some descriptions, but one cannot but give the ancient physicians credit for some keen observations. Such an observation when confirmed by modern science becomes a sound principle. An example of this kind can be found in the prevention of smallpox in civilized countries. It is true that Edward Jenner (1796) was the discoverer of vaccination but the observation that the inoculation of cowpox debris confers immunity against smallpox was previously known to the Indians and other orientals and also Europeans, especially among milkmaids. It was from the milkmaids that Jenner obtained the information, then conceived the idea of vaccination, and finally achieved his discovery. Withering's discovery of digitalis and the discovery of ergot are instances of knowledge being derived from folklore. In fact, some of our most important remedies to-day like cinchona bark, ipecacuanha, cocoa leaves, opium, coffee, nux vomica, hemp, datura, etc., are derived from folklore and empirical indigenous medicine. It is thus evident that modern medicine still owes much to the people of the past for the accumulated knowledge of many remedies and cures. A thorough investigation into some of the ancient medical systems is therefore well worth taking up.

Difficulties of Modern Therapeutic Research

The question now arises as to what is the best way of achieving such an object. The subject of revival of the old medical systems in India has entailed considerable divergence of opinion even among the learned exponents of the indigenous systems. There is a school of thought, which favours the wholesale revival of the old systems with all their paraphernalia of superstition and folklore, thus to bring back to suffering humanity in the 20th century the true teaching of Susruta and Charaka in all their pristine glories. There are others, however, who are more open-minded and critical and are keen only to receive those teachings and observations which have stood the test of time and are found of value as judged by modern science. Our knowledge of pathology and pharmacology has increased during the several thousand years that intervened between the origin of *Ayurveda*, for instance, and modern science, and

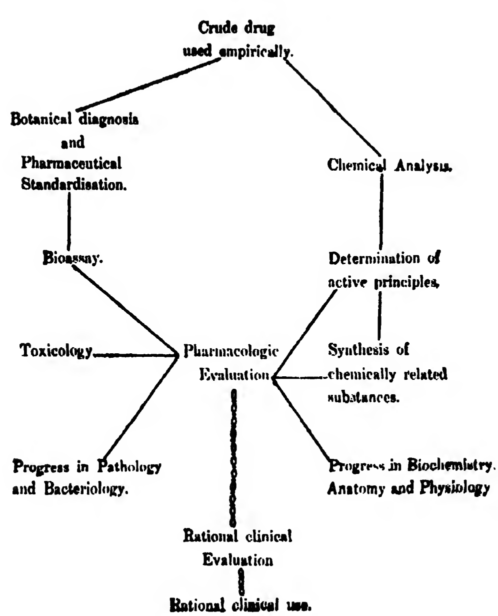
we now know that many of the ideas which formed the mainstay of the old Hindu medical practice are no longer tenable. The revival *in toto* of the old systems of medicine which have remained stagnant for such a long period and to hold them up before the modern generation is not likely to meet with great success. Unless there is a scientific background behind a particular remedy, its acceptance and use cannot be assured. In any successful scheme of revival of the old Hindu medicine, one of the chief problems which suggest themselves is a thorough investigation and enquiry, along modern scientific lines, into the rich field of the indigenous materia medica. This is likely to lead to some tangible results.

Let us now see how this can be done. The field for research in Indian indigenous drugs is obviously a vast one, but the work is not easy as may be sometimes imagined. Since the period of decay, many of the effective remedies have been lost, and a number of uncertain ones have come in without any satisfactory evidence. The result is that in the indigenous system at the present time, almost every plant and shrub growing in the country has some medicinal virtue ascribed to it. To bring order into such a chaotic state of affairs is truly a Herculean task and would constitute the life-long work of innumerable scientists. No one is qualified to undertake the task single-handed. Few institutions are properly prepared to do so. *The identification of drugs is a prime difficulty.* The character of the historical traditions is too hazy, and too many changes in terminology have taken place during the centuries to give the scientific accuracy needed. Many of the remedies mentioned in the old books defy both recognition and identification, and one cannot be certain from the description whether the specimens obtained are of the particular drug described. *The chemical analysis is the next important step.* Medicine is now intimately related to chemistry and the solution of most problems, whether physiological or biological, rests on some physical or chemical basis. The co-operation of competent chemists at every stage of drug research is the only key to success. *Next comes the pharmacological evaluation.* The pharmacological appraisal of new drugs is a difficult task and should not be attempted by an amateur. The pharmacologist must possess a keen sense of the different kinds of effects that various types of chemicals have on living tissue. He should be able to conduct a thorough and reliable toxicological testing of the different members of a series of compounds. No drug, whose tonic properties are not well known, can be used in human beings. The minimal lethal dose (killing three animals out of five) depends on many factors among which are *(a)* species, *(b)* condition of animal, *(c)* solvent and concentration, and *(d)* mode and rate of administration. It takes considerable experience to control these variables in order to arrive at sound estimates. After all these tedious processes are gone through, which may take months and perhaps years, *the clinician will have to lend his helping hand for the final solution* in his hands lies the acid test of all laboratory endeavours. The most promising laboratory achievements have often come to naught in the hand of the clinician. The introduction of a worthwhile new medicinal agent from the claims of the indigenous materia medica, therefore, requires the close co-operation of four distinct types of scientific endeavour. The following programme will indicate clearly the inter-relationships which should exist in the critical evaluation of a drug (Leake, 1932.)

Need for Co-ordinated Drug Research

It will thus be seen that a 'team-work' carried out by botanists, chemists pharmacologists, toxicologists, and clinicians, with well-equipped physiological laboratories and special research hospitals, is necessary before any satisfactory progress can be achieved. None existed in India to enable anybody to take up the problems along proper lines. Admirable attempts were made by pioneer workers to investigate the claims of Indian materia medica but their efforts had to be confined mostly to simple, chemical analysis and uncontrolled clinical trials. Chemistry, physiology, and clinical medicine were in a very rudimentary condition up to the eighties of the last century, and the knowledge of the earlier workers was naturally not sufficient to enable them

The programme indicating the Inter-relationships existing in the Evaluation of a Drug (Leake).



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to take up problems in drug research, which calls for the most up-to-date technique and methods. In 1923, a unit on the principles mentioned above was set up in the Calcutta School of Tropical Medicine under the guidance of Bt-Col. R. N. Chopra, and the unit was entrusted to investigate the claims of Indian medicine from the modern viewpoint. It will be of interest to know the direction along which this enquiry has been conducted during the last decade.

The problem was taken up from two main angles.

1. To investigate the possibility of utilization of pharmacopoeial and allied drugs growing in India in place of the official ones mentioned in the British Pharmacopoeia and the United States Pharmacopoeia.

2. To investigate the remedies used in the indigenous materia medica which have an established reputation, on strictly scientific and experimental lines, in order to assess their real value.

The first proposition is likely to lead to great results because *almost all the pharmacopoeial drugs and their substitutes grow wild and in great abundance in India. Those that do not grow can be easily made to grow in some parts of India,* as India has got a wonderful variety of climate and soil. These plants or their substitutes cannot ordinarily be used, as no standard work has been carried out with regard to the percentage composition of their active principles in terms of the official standard. Unless such work is done it can hardly be expected that they will be taken into use by the medical profession in place of more certain and tried remedies. In this particular field, much has been accomplished within a comparatively short time in India. Thus *Digitalis purpurea* grown in Kashmir has been found to have full therapeutic value and can compare very favourably with the imported leaf. The tinctures and other pharmacopoeial preparations are properly assayed biologically before they are allowed to be sold in the market. Excellent *santonin* can be prepared both from '*Artemisia maritima*' and '*Artemisia brevifolia*' growing in the North Himalayas. *Ipecacuanha* growing in Darjeeling and Burma gives a good yield of emetine which satisfies all the pharmacopoeial tests. *Valerian, Aconite, Podophyllum, Mentha. Hyoscyamus, Belladonna*, of Indian origin, are all up to and sometimes better than pharmacopoeial standards. *Colchicum luteum* of India is an excellent substitute for *C. autumnale*, *scilla Indica* for *S. maritima*, *Ferula narthex* for *Asafoetida*, *Picrasma quassioides* for *P. excelsa* and *Gentiana kurroo* for *G. lutea*. Indian Ephedras have been found in many instances as good as the best Chinese Ephedras.

These results are very valuable in poor countries like India where the medical and public health budget is ridiculously limited, compared with that of other civilized countries. The confidence of the medical profession is gradually being created for the local plant products Indian manufacturers are now organizing for the exploitation of these resources and once the wheel is set going, the cost of medicines would be enormously reduced, enabling the poor masses to get the benefit of modern medicine. It sounds queer but nevertheless it is true that though India is the home of *Nux Vomica and tea, still no strychnine or caffeine is produced in India.*

The second proposition of popularizing and introducing new drugs from the claims of Hindu medicine has not yielded very satisfactory results so far. There is such an enormous field and so little has been done that no definite statement either on the positive or negative side can justifiably be made. A few important medicinal plants and one or two mineral remedies of outstanding reputation have been carefully investigated from all viewpoints. Their chemical composition has been determined, the pharmacological action of the active principles and the toxicity tests have been worked out by animal experimentation, and finally, suitable preparations made from the drug have been tested on patients in hospital. *This work has brought into prominence the merits and qualities of certain drugs and have shown that these will form valuable additions to the armamentarium of the physicians, if brought into general use.* Such drugs, unfortunately, are not many. A few showed certain amount of therapeutic

activity, not superior to that of the drugs already contained in the pharmacopoeias. No epoch-making discoveries have thus far been made. *It has also shown clearly the worthlessness of quite a large number of the so-called "cures" of the indigenous materia medica.* Disappointments have been the results in the large majority of cases, but the situation must have to be faced. Only systematic work in well-equipped laboratories and by well-qualified workers can remove the chaff and bring to light the real teachings of the Hindu medicine.

Research in Ancient Hindu Materia Medica—A Promising Field

It may be emphasized that there is hardly any truth in the oft-repeated statement that there is nothing worth while in the ancient Indian medicine, simply because empiricism and superstition form such a large part of it. We must not forget that these ancient people were faced, as we are to-day, with the same life-and-death struggle with natural enemies and adverse environmental conditions, and the very fact that they survived the ravages of epidemics and diseases is a proof that they must have adopted definite measures to fight against them. A system which has survived to such an extent the destructive influence of time and a system which is still a living system in many parts of India cannot entirely be brushed aside as unscientific. According to Dr Hugh S. Cummings, the president of the U. S. Pharmacopoeia Commission, "any system of medicine or for that matter, any ancient usage or custom that has held its own for generations usually has something at the back of it, no matter how little it appears to be supported by modern science. For generations the fact that the American Indian hunters always chose the liver and the whitemen the meat, when the animals they trapped or killed were divided, was quoted as proof of their ignorance and primitive development, yet in the last 5 years, the great nutritive value of liver has come to be recognized and is universally prescribed in cases of anaemia." Further, scientific and well-controlled investigations have on more than one occasion proved that at least some of these remedies richly deserve the reputation they have earned as cures. A very convincing example in support of this statement is the rediscovery of Ephedrine from the ancient Chinese materia medica of 4,000 years ago. True, there have crept in, during the passage of centuries, many things with doubtful utility and questionable value, but it may be confidently hoped that if passed through the scientific machine, the useless things will be completely eliminated. As has been aptly described by Prof. Read in one of his papers, "Modern Science is like a furnace through which we need not fear to put out precious lore. The rubbish will be burnt up but the purified and glistening treasure will remain." The field for research is a vast one and no single individual or single institution can cope with it satisfactorily. Pioneer work has been done both in India and China, the countries with the richest lore, but a great deal more is left behind. What is required is a well-organized team-work among botanists, chemists, pharmacologists, toxicologists and clinicians all over the world in a joint endeavour to find the truth. Modern medicine is a universal system. Distinctions are often drawn between the Western system of medicine, the Indian medicine, the Chinese medicine, and so on. Medicine has no limits and boundaries. Modern medicine is as remote from Western systems like allopathy, homeopathy, osteopathy and chiropraxis as it is from Chinese and Indian systems of medicine. It is a curious blend of information where side by side with the most up-to-date chemotherapeutic and synthetic remedies, there are the century-old remedies from all over the globe—opium, nux vomica, hemp, datura, many spices, mercury, etc., from India, cinchona from Peru, ipecacuanha from Brazil, strophanthus or kombe arrow poison from Africa, coffee from Arabia, digitalis from Great Britain, cocoa leaves from Peru, antimony from Greece, and a host of others from various sources. Modern medicine man is a seeker after truth and his duty is to pick up the best from every system, whether it is emanating from India, China, or any other part of the world, and to knit all the experience together in freeing humanity at large from "the sufferings which flesh is heir to".

Mineral Nutrition in Agriculture

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With the remarkable series of discoveries regarding the constitution of matter in the 18th Century, the science of chemistry was applied on a true and accurate basis in the development of agriculture. The admirable work of de Saussure established the fact that plants obtained their carbon mainly from carbon dioxide of air rather than from soil. Sprengel was studying the ash contituents of the plants which he assumed to be of distinct importance in agriculture. Boussingault was working on pot experiments to show which of the elements in the plants were derived from the soil which were essential to the growth of plants. Schrubler was working on the principles of soil physics. It was not until Liebig's classical work, *Chemistry in its application to Agriculture and Physiology*, was published in 1840 that any very serious consideration was given to the study of soil in its relation to crop production. He pointed out that elements such as nitrogen, potash, lime, and other substances were essential to the growth of plants.

The bulk of the plant is composed of carbon, oxygen, hydrogen, and nitrogen, which in an infinite number of combinations form almost all the organic compounds of the plant. With the spread of the knowledge of the function of plant organs, the importance of other elements was known. Of all the mineral elements that have been investigated in the ash analysis of plants, potassium, phosphorus, nitrogen, calcium, manganese, magnesium, iron, and sulphur are considered to be of paramount importance in the growth and yield of the crops. Some of these elements are responsible as catalysts for the chemical reactions between the organic compounds of carbon, hydrogen, and oxygen, and for these reasons mere traces suffice, while others function in building up plant substances. Nitrogen, potasium and phosphorus are included in the latter and are required in such large quantities that in agricultural practice they are usually added to soil as artificial fertilizers in order to obtain a good yield of crops. The use of artificial fertilizer was first attempted by Liebig and he introduced a patent manure, based upon the chemical composition of the natural guanos but made up of prepared salts, which he offered as a complete and satisfactory fertilizer for all crops and for all soils. This patented fertilizer failed to meet his expectations and was abandoned.

In nearly the middle of the 19th Century Sir John Lawes and Sir Henry Gilbert established the famous plot experiments at the Rothamsted Experimental Station, England, to determine the efficiency of various compounds in increasing the growth of crops; and by field trial the efficiency of the chemical manuring was established according to the nature of the soil. Since 1852 field experiments are being continued there year after year on the same ground, manured with the same substances and sown always with the same crops; and even now after 85 years of chemical manuring these plots continue to produce good crops. In the problems of nutrition the function of the elements, potassium, phosphorus, and nitrogen, as chemical fertilizers in the growth, yield and physiological processes of plants, will be briefly discussed in the present article.

Potassium (K)

Potassium is abundant in the regions of active growth. Chemical analysis of the corn plant at maturity shows that 45% of potassium in plant is located in the leaves, 32% in the stem and the rest in the grains and roots. The high percentage of potassium in the growing regions is attributed to the meristematic activity of the cell and to the active protein synthesis that is going on in these

regions. Plants generally absorb inorganic compounds of potasssium from the soil and as a commercial fertillizer potassium sulphate is generally used. The application of K-fertilizer depends on the nitrogen content of the soil ; the two nutrients are intimately linked together in their action. Under small supplies of nitrogen on all types of soil K-starvation results in the ashy-grey colour and stunted growth of the plants, the leaves die prematurely, death is first noticed at the tips and then proceeding along the outer edges. The fruit and seed become small in quantity, size, and weight. K-fertilizer in these soils is found to act well on all crops. The soil with an ample supply of nitrogen but deficient in potassium is responsible for the large growth of leaves, but the latter become inefficient in metabolic activities as the carbohydrate metabolism is reduced. On account of increased nitrogen supply from the soil, a considerable uptake of nitrogen results with less synthesis of carbon compounds. Thus the carbon-nitrogen ratio (C/N), the effect of which is to regulate the vegetative and reproductive growth, becomes unbalanced. As a result of this many undesirable effects are noticed ; the power of the plants to resist diseases is diminished. In the Rothamsted Experimental Station in plots recieving excess of nitrogen but no potash, wheat is attacked by rust, mangolds by a black bacterial blotch, but plots adequately supplied with K-fertilizer reduces the chances of tomato being affected by streak disease and blotchy ripening, and potato or young orange trees by brown patches. The addition of sufficient K-fertilizer in these plots has considerably increased the power of disease resistance. The reason is found to be the increase of the net production of sugar and starch in the leaf and thus the C/N ratio is brought to a normal value which is disturbed by an excessive uptake of nitrogen. Respiration increases markedly under K-deficiency, while assimilation or carbohydrate synthesis is greatly reduced. The net result of the two processes in the life-history of the plant tends to decrease the carbon compounds without affecting the total nitrogen.

Although potassium has no part in the constitution of carbohydrate, yet the plant seems to be unable to combine carbon, hydrogen, and oxygen into carbohydrate products except in the presence of K-salts. No definite conclusion is reached as to the way K-starvation interferes with carbon synthesis, but a suggestion (Gregory) has been made that the chief action of potassium is to determine the rate at which carbon dioxide diffuses through the cell to the chloroplast surface. The other view (Loew) is its superiority as a condensing agent, the carbohydrate synthesis being considered as a process of condensation. The suggestion is drawn from instances in organic chemistry where condensation process takes place only in the presence of potassium or much more readily than with related elements. The effect of K-deficiency in the reduction of carbohydrate production is noticed even before any diminution in the vegetative growth of leaves and stems can be observed. As the carbohydrate supply is limited under K-deficiency a very poor development in mechanical tissue due to the lack of reserve carbohydrate supply is noticed. For the poor development of mechanical tissue grasses under potassium starvation do not stand up well. Potassium salts facilitate the entry of water into the plant. In cold, sunless season transpiration is less consequently less uptake of nutrients ; under these conditions the effect of K-fertilizer is to facilitate the entry of water-carrying nutrients. On the other hand K-deficient plants act well under bright sunshine when water conduction is more active. Plants grown in a soil containing proper amount of K-fertilizer are found to be less affected by wide variations of water supply, while without potassium they are much more sensitive. In the process of ripening K-fertilizer helps in increasing the weight and quality of the grain. Plants differ in considerable degrees in their response to K-fertiizer ; the quantity to be added to the soil depends on the nature of the crops that are being grown. It has been shown that wheat, oat, rye and carrot are satisfied with a small supply of potassium salts, while barley, potato and cabbage require a medium supply ; and onion and tomato a large amount.

Phosphorus in plants occurs in greater amounts

in the seeds and fruits; more than 50% is in the cobs and grains. The amount of phosphorus found in plant tissue will depend upon the amount present in the soil; and it has been shown that up to a certain point the production of plant substance increases with the phosphorus supply, but beyond this, phosphorus is not utilized in an increased plant growth. The phosphate absorbed remains unmetabolized in inorganic form and sometimes leads to phosphate poisoning. The crop yield is depressed by an excessive supply of phosphorus. On phosphorus nutrition Russel writes: "The relation between phosphate supply and phosphate content of the crops is of great practical importance. Over large areas of the world soils are deficient in phosphate and the herbage they carry is therefore also deficient so much so that it may fail to supply grazing animals with all phosphorus they need. The animals then suffer from a deficiency disease which may be very serious. The animals devour bones with great avidity, even putrefying bones, and so they become further liable to ptomaine poisoning. The remedy is to treat the land with superphosphate or, if this is too costly, to supply the animals with bone meal". Superphosphates are generally used as phosphate fertilizer. The application of phosphorus promotes root formation. In the dry regions the rapid growth of roots down into the deeper layers compensates the scarcity of water supply in the surface soil. Phosphate dressings are used for root crop like turnips, mangolds. In the absence of phosphorus the roots do not swell but remain permanently dwarfed, and their market value is greatly diminished. P-fertilizer also induces earlier ripening of the grain crops, cabbage and cotton, etc., growing on soils low in phosphorus; for this reason they are applied to crops requiring early maturity in order to avoid the risk of loss by bad weathers. By hastening the ripening process the leaves of barley or other such plants could be made free from the larval attack of some insects, the eggs of which lying in the top of the topmost leaf hatch late in the season and then proceed downwards towards the head for food. Increasing the rate of application, however, above the needs of the crop does not help it to ripen earlier. It is generally the first few weeks that the crop plants take up sufficient phosphate for full normal growth. Supply of the fertilizer later than this period in a deficient soil is not always very effective. Plants grown under phosphorus starvation are characterized by the dark-dull-green leaves and a reduced number of tillers. Cereals suffering from P-starvation have a stunted root-system, especially in their early days, and even more stunted leaf and stem. Potassium starvation depresses tillers causing a decrease in the total number of tillers and the number of tillers bearing seeds. Similar stunting of the root, shoot, and leaf is seen in phosphorus-starved fruit-trees. The effect is also exhibited in depressing the yield of straw and of grains.

The relation between phosphorus supply and the rate of respiration has been known for a long time. The part played by phosphorus is considered to lead to the esterification of sugar for carbon dioxide production. P-deficiency is accompanied by low carbon dioxide production and thus the energy liberated is small in the regions of active synthesis (leaves). In the internal composition of plant substances, the effect of starvation is very remarkable. The detailed investigations of Gregory and his collaborators in the Rothamsted Experimental Station have brought out the importance of phosphorus in the carbohydrate and nitrogen metabolism of barley. In phosphorus starvation the carbohydrate and nitrogen metabolisms are seriously impaired, the syntheses of protein and sucrose are inhibited, and there results an accumulation of reducing sugars and of amides. The accumulation of these simpler compounds of carbon and nitrogen occurs precisely at the same stage of the plant. Simultaneously at this time the symptoms of phosphorus starvation are noticed in the leaves. The work continued further by the present author in the same institute has shown that the protein synthesis could be revived when phosphorus was supplied to the starved leaves. Phosphorus was found to be necessary for the conversion of amide to protein. It was also pointed out that a close relationship between carbohydrate and nitrogen metabolism and its dependence on phosphorus is established. Phosphorus is also necessary for the formation of lecithin. In its absence the formation of lecithin does not

occur and, as a consequence, there is an accumulation of fat in the cells.

Nitrogen (N)

Nitrogen nutrition is responsible for protein metabolism. Supply of nitrogen below a certain level reduces considerably the protein content, while an increased supply above the normal requirement does not lead to an increased protein synthesis. It is absorbed by the roots in the form of either nitrates or ammonium salts. Atmospheric nitrogen is made use of by the leguminous plants with the help of symbiotic relationship of micro-organisms in the soil and the roots of legumes. Some non-leguminous plants, cucurbita pepo, wheat and barley are reported to have assimilated atmospheric nitrogen without the aid of symbiotic micro-organisms.

Before nitrogen is metabolized to protein a series of complex reactions occur. It is assumed that the availability of ammonia ion to the synthetic organ is the starting point of protein synthesis from simpler inorganic compounds. Nitrates before entering into protein composition are converted to ammonia, which is really the true nutrient. In agricultural practice nitrates are commonly used in preference to ammonium salts. The relative values of nitrates and ammonium salts in plant nutrition depend on two important factors, namely, the hydrogen-ion concentration of the medium, whether it be a nutrient solution or the soil, and the amount of carbohydrates present in the plant.

Plants absorb ammonia-ion from ammonium salts, leaving the acid radicle, which tends to increase the acidity of the medium and becomes toxic to the plant unless some balancing cation is present in the soil or added in the form of fertilizer. In cases where nitrogen is added to the soil in the form of ammonia, it is the usual custom to furnish an extra supply of calcium or sodium or to investigate into the abundance of some cations in the soil to overcome the toxic effect. Absorption of nitrogen from sodium or calcium nitrate leaves no toxic ion behind and, therefore, has no harmful effect. In some plants, however, the ammonium salts have a higher coefficient of utilization than nitrate salts. Rice is found to grow well and produce better yield when nitrogen is applied in the form of ammonium salts.

In nitrogen metabolism asparagine plays an important role. It is regarded as the best innocuous store of the excess of ammonia for future use. It is synthesized when ammonia combines with the residues of carbohydrate-oxidation. Accordingly the rate at which ammonia could be utilized depends upon the quantity of carbohydrates present in the plant. The plants like barley, maize, and rice, relatively rich in carbohydrate, readily take up ammonia to form asparagine and hence the supply of ammonium salts is an effective fertilizer. On the other hand, lupins containing a small carbohydrate will not assimilate nitrogen from media containing ammonium salts even in presence of calcium salts. Ammonia absorbed remains uncombined and becomes toxic to the plant.

The symptoms of nitrogen starvation are stunting in growth and yellowish or reddish green colour of the leaf. The yellowing and dying of the leaf are noticed all over the leaf as distinct from the effect of potash starvation where death of the leaf starts from the tips and proceeds downwards. Under nitrogen starvation the leaves are shed early and the fruits become coloured, the root system is reduced and becomes almost entirely fibrous. Addition of sodium or calcium nitrate to a nitrogen-deficient plant revives the normal colour of the leaf and the increased height of the plant. A large amount of nitrogen in the soil produces a rank growth of foliage but retards the ripening process ; shrivelled grains and seeds are the result. Plants, as cabbage and lettuce, which are cultivated solely for the leaves, are benefited by an abundant supply of nitrogen. Judicial application of nitrogen fertilizers improves the size of the leaves and imparts tenderness and bright colour to the leaves, which have much market value. On the other hand, the leaves supplied with an abundance of nitrogen develop very thin-walled cells which make some plants more susceptible to fungus and insect attack. Infection of wheat rust is known to spread

through the thin-walled cells under supranormal supply of nitrogen. A large supply of nitrogen prolongs the vegetative phase, the ripening process or grain formation is very much retarded. The difficulty in cauliflower to form the edible inflorescence in the same soil having an abundance of nitrogen, where cabbage leaves are much benefited, is undoubtedly due to the differential effect of nitrogen supply in retarding the reproductive phase of cauliflower and in the luxuriant growth of the leaves of the latter. An excessive supply of nitrogen prolongs the vegetative phase of all cereal crops for a longer time, too much straw is produced which becomes comparatively weak and is lodged by wind and rain. Similar unbalanced growth is exhibited in potatoes and tomatoes; in the former the tuber is proportionately less developed than the leaf; tomatoes under such condition produce too many leaves and too few fruits.

Although these effects of nitrogen supply are very apparent, yet the plants to a certain extent seem to adjust to the environmental condition. As mentioned before, C/N ratio is an important factor in growth processes. In order to maintain a normal ratio, plants are found to accommodate in the soil by varying the area of the leaf and changing the assimilation rate. In cases where soil contains an abundance of nitrogen it is desirable to increase the potash supply, thus increasing the efficiency of leaves to carbohydrate production. But when the soil has a very high percentage of nitrogen, potash addition is without any effect to balance the C/N ratio and the harmful effects appear.

Relativity Tested

S. M. Sulaiman

Chief Justice, High Court, Allahabad.

Professor Albert Einstein has frankly admitted that his Theory of Relativity rests solely on three criteria: (*i*) The advance of the perihelion in planetary orbits, (*ii*) the deflection of light from stars by the sun's gravitational field, and (*iii*) the displacement of spectral lines towards the red end of the spectrum. "*If a single one of the conclusions drawn from it (his theory) proves wrong, it must be given up; to modify it without destroying the whole structure seems to be impossible*".[1] According to the principle of General Relativity, the cause of the difference between solar and terrestrial wavelengths is the slowing down of the atomic clock in the sun. This effect is, according to Einstein, the same all over the sun's surface with the result that the spectral shift should have the same value, no matter from what point on the sun's surface the light is received, *i.e.*, at the centre or circumference or any point on the solar disc.

According to the theory given by the present writer,[2] the spectral shift should vary rapidly from the centre to the edge, in accordance with the formula $\Delta\lambda = (1+\sin^2 a) \times$ Einstein's value, where a is the angle between the line of sight and the radius of the sun. This formula makes the value of red shift of the edge of the sun double that at the centre and therefore double of the Einsteinian value.

Previously, St. John, in measuring the shifts at the edge, had made a rather curious selection of lines confining them mostly to the ultra-violet region, and altogether left out of account the entire range of the blue, the violet, and the red, and never measured the limb shifts in these regions. Nevertheless, he observed a fairly large divergence from

1. Relativity on Trial, Science & Culture, 2, 344, 1937.

2. *Ibid*, p. 345.

Einstein's theoretical value at the edge and attributed it to some unknown and unexplained "edge effect".[3]

Dr J. A. Evershed[4] had in 1923 felt no doubt that there was a considerable excess of red shift at the sun's limb. Further observations proved that "the high and low level lines which at the centre of the sun give very appreciable plus and minus residuals give nearly equal shifts near the limb.... The increase of wave-length from the centre towards the limb becomes very rapid as the limb is approached." Later[5] he made careful measurements of the limb shift as the limb was approached. As previously noticed by Freundlich, Brunn, and Bruck[6], he also conceded that mysterious large excess of shift at the limb could not be explained by simple Compton scattering due to the long optical path from the limb, because exactly the same excess was shown by the spectra where the light does not traverse any portion of the chromosphere, and the lines are not widened as they are in limb spectra. In order to explain it as being due to Döppler effect, he felt compelled to assume a recession at all points on the limb directed at all times away from the earth. But a supposed repulsion from the earth at all points on the circumference of the solar disc was both objectionable and untenable. He gave certain curves for the difference between the spectral shifts at the edge and at the centre and arbitrarily imagined that the curves approached one, of which the ordinates are the versed sine (*i.e.*, 1-cosine) of the central distances. A comparison of his curves will, however, show that, except for the middle, they follow the general trend of the ratio $\sin^2 a$, where $\sin a$ is the abscissa. Dr Evershed rightly concentrated attention on the measures of limb and arc in the red region, where atmospheric scattering is less than in the more refrangible part of the spectrum and found large values of the shift which were subsequently confirmed. His final conclusion was that "*in the red, the limb effect is nearly equal to the Einstein effect; in other words, the shift at the limb is probably equal to the Einstein effect multiplied by 2.*"

3. *Astro-physical Journal*, *47*, 201.
4. *Monthly Notices*, *96*, 152.
5. *Monthly Notices*, *91*, 260.
6. *Zeitschrift für Astrophysik*, *1*, 43.

It was accordingly eagerly expected that at the last total solar eclipse of June 19, 1936, excellent spectra would be obtained giving the real values of the limb effect freed from the effect of scattered light from the central part of the disc. Dr Royds, whose expedition to Japan had been financed by the Government of India, obtained excellent photographs, and his results were keenly awaited. These results were recently announced before a joint meeting of the Royal Astronomical Society and the Royal Society of London. Three important results certainly come out from his observations[7].

(1) There is very little difference between the values of the solar displacements derived from eclipse plates and those derived in full sunlight. This fact is of considerable importance, as it will be a great encouragement to astronomers to make measurements of the spectral shifts of light from all parts of the solar disc, without waiting for any total or annular eclipse.

(2) There is decidedly a marked and progressive increase in the shift from the centre towards the edge, and this is true for all levels and for lines of all intensity. This undoubted circumstance disproves the result in Relativity that the spectral shift should remain the same all over the surface. Dr Royds, instead of boldly saying that his results definitely disprove the Relativity Theory, has mildly remarked, "The explanation in terms of convection currents for lines of different intensities originating at different levels in the sun, which had been offered for the discrepancies at the centre of the sun, could not hold for the limb, and the divergences from the predicted Einstein displacements have yet to be explained."

(3) The excess at the limb is decidedly so large as to be far beyond all possible errors of observation, so that a serious divergence from the Relativity value can no longer be disputed.

7 *Nature 140*, July 3, 1957, 11.

RELATIVITY TESTED

Even excluding the correction required for reducing the shift from air to vacuum, Dr Royds' eclipse observations give :-

Intensity	*Centre*	*Limb*
11.0	0.0076	0.0126
5.2	0.0088	0.0151
3.2	0.0058	0.0116
Average value 6.46	0.0078	0.0131

These values show that the shift at the edge is nearly double of that at the centre.

Dr Royds had strangely enough omitted to introduce an obvious and necessary correction if wave-lengths in the vacuum were to be used. It was left to Dr Evershed to point out at the meeting that "to reduce his (Dr Royds') shifts from an arc in the air to an arc in vacuo meant an increase of 0.003 Å, and that with this correction *the displacement at the limb was twice the predicted Einstein value.*" Thus there has been the clearest cofirmation of my formula and the shift at the limb is in *exact* accordance with it.

Dr Royds' full paper is not yet available and detailed comments must, therefore, be held over. It, however, appears from its summary that Dr Royds has curiously enough lumped together rays of different wave-lengths, and presumably taken only their average value. It is well known that the red light is the least subject to refrangibility and scattering. The conditions of the solar atmosphere cannot be certain and are indefinitely known. The results would be of greater value if the effect in the red region were closely and separately examined and not mixed up with that in the region of shorter wave-length.

No doubt the average variations do not appear to be the same for the lines of different intensities. But it must be remembered that different intensities imply different levels from which light comes, the weaker lines coming from the deeper layers and the stronger lines from the higher layers.

It is not clear what further corrections he has made for the earth's rotation and orbital motion, the sun's rotation as well as small corrections for pressure at the solar surface ; nor is it yet known how many plates he actually obtained, because, for reliable average values, it is essential that a considerable number of plates (according to Dr Evershed there should be at least 20 spectra) should be taken so that in taking the average the effect of any irregular, radial, or superficial currents may be got rid of.

The shifts at the edge are probably under-estimated, because the spectra would be obtained from a region within the limb. Also the observations of the rays at the centre cannot be accurate as the effect of scattering in their case is extremely large. Indeed, the measures of the shift across the disc are rather uncertain on account of the width of the solar lines when high dispersion is used, even apart from Döppler shifts due to local currents. Slight deficiencies can also be expected owing to errors of observation.

Further results, particularly those derived from the shift in the *red* region, taken at all points of the solar surface, will furnish conclusive tests of my formula $\Delta\lambda = \Delta\lambda_{\text{Einstein}} \times (1+\sin^2 a)$, which for the difference between the centre and the edge gives a parabolic curve, explaining the progressive shift, which both the usual wave theory of light and the Relativity hypothesis of a slowing down of atomic clocks completely fail to do.

It will take a few months before the results of Professor Michailov's observations of the deflection of light from the stars due to the sun's gravitation become known, showing whether the value is equal to Einstein's or, as predicted by me, lies between 4/3 and 3/2 times as much.

In the meantime, I have ventured to make a *third prediction* that if the Michelson-Morley experiments were performed with light from the sun, or preferably from a star, and not with terrestrial light produced on the earth, the null effect would vanish, establishing the corpuscular character of light and also destroying the fundamental postulate of Relativity.

P. C. Ray—the Man and the Scientist

THE recent retirement of Sir P. C. Ray from the Palit Chair of Chemistry of the University of Calcutta recalls to mind a career, which is indissolubly associated with the history of the last four decades of India's renaissance. Made of the same stamp as Ram Mohun Roy and Vivekananda—at once a seer, a critic, and a fighter—Acharyya Prafulla Chandra has given his indelible impress to the movement of India's awakening in practically all spheres, social, political, literary, scientific, and industrial. It is difficult to choose in paying a tribute to his myriad-sided personality. A life, indeed, truly amazing in richness, variety, beneficence, and high endeavour !

Prafulla Chandra, the man as is known to those who know him well—has few equals in India. Unselfish beyond belief, simple in habits to a fault, supremely contemptuous of money, he has dedicated his life to the pursuit of science and good of humanity without ever being lured into the paltry ways of the worldly man. People there have been who have earned and enjoyed wealth and then given it up. But it is rarer to find men, who, though capable of commanding luxuries, have eschewed them at the very outset of their life. Prafulla Chandra has not merely avoided luxuries and worldly possessions, which most men value, but has even shunned what many would consider to be ordinary amenities of life. And his almost ascetic habits have been fittingly complemented by his princely munificence for the benefit of varied organizations, including the University of Calcutta. We make no apology for stressing this aspect of his life as it is in sharp contrast to the selfishness, greed, and desire for possession that we see all about us in our present unjust and unequal social order.

A highly critical and intellectual man, Prafulla Chandra early turned his analytical mind to contemporary social problems. His writings, his speeches, his ceaseless efforts to shatter the cobwebs of superstition, unreasoned belief, and obscurantism, and to steer the Indian mind towards light and reason have contributed in a very large measure to the development of the critical mind in modern India. Prafulla Chandra does not believe in compartmentalism in thought and behaviour. He insists on the inculcation of the scientific attitude of mind to all problems that face us in the big theatre of life as much as to experiments and observations in the laboratory. This divorce between laboratory and life, he has often said, is the bane even of many Indian scientists. Few men have striven so hard for the cause of rationalism in India.

Combined with a keen and powerful intellect, Brafulla Chandra has a heart, which is wonderfully kind and generous. He has shown this not merely by numerous benefactions and personal charity but by his untiring work on occasions when tens of thousands have been thrown into distress by natural catastrophes. On occasions of political sufferings, inevitable for a people struggling for life and freedom, the nation has been touched by his vibrant patriotism and poignant sympathy. The love for his country is so deep in him that it is impossible for anybody to be near him and not to be affected by it.

Prafulla Chandra's tremendous and successful efforts for the industrial development of the country need not be retold. While shunning wealth for himself, he has always tried to create wealth for the nation. His original scientific achievements and the creation of the Indian school of chemistry are monuments in which he will ever live. Scientific honours have come upon him thick and fast. He has received world-wide recognition not only for his researches but also for

(*Continued on page 171, Col. 2.*)

Notes and News

British Experts on Educational Reorganization

The proposals adumbrated by Messrs A. Abbott and S. H. Wood, British Educational Experts, who were invited last year to advise the Indian Government in respect of the educational reorganization and particularly on the problems of vocational education, include the establishment in each province of an Advisory Council on vocational education, consisting of the Directors of Public Instruction and of Industries, the principals of the vocational colleges in the province and four or five important businessmen selected by the Government. The duties of the Council will be to see that their branch of vocational education functions successfully. According to the Experts, full-time vocational schools fall into three types:—

(a) Those which impart a vocational bias to their curricula during the last year or two of school life. *(b)* Those which prepare their pupils for work in an occupation to be selected at the end of the course from a range of related occupations. These are pre-apprenticeship schools. *(c)* Schools which prepare their pupils for a specified occupation. These are apprenticeship schools and are sometimes known as Trade Schools.

Messrs Abbot and Wood stress the necessity of cultivating a bias toward the needs of agriculture through their curriculum which should be a continuation of the Rural Middle School, and the desirability of giving a training, in junior vocational schools, preliminary to employment in industries of the manipulative variety suitable for boys who aim at becoming highly skilled artisans and foremen. The Experts deprecate the insufficient attention given in this country to the teaching of art, and suggest that the spheres of influence of the existing schools of arts and crafts should be enlarged considerably; and that other schools of arts and crafts working in close association with them should be set up as opportunity serves.

There is little possibility of the cultivator, says the report, becoming a successful small-scale worker, though the village artisan might be trained to repair and refit agricultural implements. But, in our view, it is the villages where some stimulus should be applied to cottage industries and cottage gardening with the many sidelines which can be run in conjunction with these. Such developments would serve the purpose of giving some profitable employment to the villagers during their idle months. We should also point out that the conquest of illiteracy is the urgent need of the moment and the villages, it seems to us, require nothing more at present so far as their education is concerned than an adequate number of well managed primary schools which will include an interesting syllabus comprising useful sidelines of local industries and horticulture, hygiene and recreation.

Radio Organization

Recently Dr M. N. Saha in an interview with the correspondent of the *Amirta Bazar Patrika* dwelt on the question of the reorganization of the Indian Radio Service at some length and strongly advocated the establishment of a committee consisting of officials, non officials, representatives of various interests and expert scientists to whom the whole management should be entrusted. This system is followed in Enland and other civilized countries. At present Indian broadcasting is a wholly official affair, and has all the defects of such a system. Recently a leading article in *The Times* of July 28 discussed the future possibilities of broadcasting in India and "expressed the opinion that there seems to be a very strong case for the early transfer of the control of Indian broadcasting from the Government to an independent corporation of officials and non-officials on lines similar to those of the British Broadcasting Corporation." This is exactly what Prof. M. N. Saha suggested . We fully agree with the views of Dr Saha and *The Times*.

Proposed Museums' Conference

It has been proposed to hold an Indian Museums' Conference this year at Delhi. When interviewed in this connection, Dr K. N. Sitaram, the Curator

of the Central Museum, Lahore, said "I hope that the Indian Mesums' Conference which is to be held in Delhi early this winter after a lapse of 30 years, will take such steps which would ensure, in the words of His Excellency Lord Linlithgow, the quickening of the creative impulse in the field of indigenous art and literature", Dr. Sitaram added:—

I want a museums' association formed on the model of British Association, this body to have a journal which would not only guide and co-ordinate the activities of curators but serve as a propaganda medium to make the nation museum minded.

I trust that with the sympathetic guidance of Lord Linlithgow, the Museums Conference will become an annual feature. Such annual conference would help to bring about greater co-operation between curators and the Archæological Department than exists at present.

In the carrying out of the provisions of the Ancient Monuments Preservation, Act, curtors could be of the greatest service.

They can also render help in seeing that rare and valuable antiquities, and works of art do not leave this country. Five years ago India lost the very rare illuminated manuscript—*Nizami*--which could have been secured for Rs. 2,000 but which was sold in America for Rs. 14 lakhs.

I hope that as a result of the discussions at the Delhi conference there will be evolved a system of exchanges of exhibits between various museums, thus helping to diffuse culture throughout India. The need for affording facilities to curators to visit the various museums in India and also those in other countries cannot be over-emphasized.

A most important subject which is not envisaged on the agenda yet is the need for taking steps to repatriate to India some of the antiquities which are now to be found in the Western Countries. In this task the help of the League of Nations may be sought, as is done by France, Germany and other European countries.

Live Stock Wealth of India

A Press Note of the Government of India issued some time ago gives interesting statistics of livestock in India for the year 1934-35.

This estimate places the number of bovine animals comprising oxen and buffaloes for British India at 159,935,000, the total number of bovine animals comprising sheep and goats at 61,157,000 and that of other animals comprising horses and ponies mules, donkeys, and camels at 3,801,000.

Of the provinces, the United Provinces have the largest number of bovine animals, namely, 32,470,000. Bengal comes next with 25,287,000. Madras is third with 24,607,000. Some of the other important provincial figures are as follows:—

Bihar and Orissa—21,308,000; Punjab—15,840, 000; Central Provinces and Berar—13,844,000; and Bombay—12,596,000.

The largest number of ovine animals is in Madras, namely, 18,701,000, the United Provinces being second with 10,002,000.

The United Provinces have the largest number of ploughs, namely, 5,196,000, the second largest figure being in Bengal namely, 4,592,000.

Madras has the largest number of carts, namely, 1,194,000, the Central Provinces and Berar being second with 1,147,000.

The number of livestock of the bovine class (cattle proper), per 100 acres of sown area and per 100 of the population in each province is as follows:—

	Per 100 acres of sown area.	Per 100 of population.
Ajmer Merwara ..	134	86
Assam ..	100	69
Bengal ..	108	52
Bihar and Orissa ..	88	57
Bombay ..	38	60
Burma ..	34	42
Central Provinces and Berar ..	56	89
Coorg ..	100	84
Delhi ..	75	24
Madras ..	75	53
North-West Frontier Province ..	50	44
Punjab ..	60	67
United Provinces ..	91	67

Coming Jubilee of the Indian Science Congress

The coming session of the Indian science Congress, which is to be its Silver Jubilee session, will be

held from January 3 to January 9, next year. As our readers already know, a number of eminent foreign scientists are expected to attend the session. In a recent meeting held at the Calcutta University the arrangements to be made for the Jubilee session were discussed.

For the purpose of scientific deliberation the Congress will be split into 13 sections and meet daily in the morning for reading of papers. There will be a number of discussions on subjects like chemistry and the industrial development of India, a national herbarium for India, nutritional diseases in India, diet and adaptation to climate, etc. A symposium on river physics will also, it is hoped, be arranged.

Arrangements for excursions to the following places of interest will be made: Tatanagar, Assam oil fields, ancient Gaur and Pandua, Darjeeling, Gosaba, Bolepur. Excursions to local places of scientific, technical and industrial interest will also be made. A number of evening lectures by some of the most eminent scientists from abroad will be delivered.

A reception committee was formed at the meeting to help in the organization of the celebrations with Mr. S. P. Mookerjee, Vice-Chancellor of Calcutta University, as chairman, and Dr S. C. Law, Sheriff of Calcutta, as Honorary Treasurer.

Petrol from Coal

Coal and petrol are the two most important sources of power to-day and the countries which possess enough supply of these two fuels in their own soils must consider themselves lucky. For many purposes either of these materials can be successfully used but in certain matters, *e.g.*, in aviation, petrol cannot be substituted by coal. Geographical distribution of petroleum, however, is much less uniform than that of coal and among the leading countries of the world only U. S. A. and Soviet Russia have adequate resources of natural oil within their boundaries. Other countries, *i.e.*, Germany, Great Britain, and Japan have to import their requirements from outside. It is needless to point out that during war time, when a large supply of petrol is an absolute necessity, the outside supply may be obstructed and even stopped. Rumours of a possible war have, therefore, driven the powers, who now depend upon foreign supply, to develop chemical methods of manufacturing petrol from coal. There are two principal methods of doing this: (i) by hydrogenation and (ii) by low temperature carbonization. These methods have already been discussed in our columns in the course of the following two articles: "Petrol from Coal" (*Science and Culture, 1*, 733, 1936), and "Low Temperature Tar and Liquid Fuel" (*Science and Culture, 2*, 574, 1936).

Germany, which is the pioneer country in this industry, started production in 1934 with State help and has increased her production at a rapid pace. In 1935, her total output of coal oil was nearly 200,000 tons. In 1936, the output rose to more than 500,000 tons. In this year bituminous coal and coal tars were, for the first time, used to a large extent and from July the German Supervisory Bureau for Mineral Oil prohibited the use of crude coal tar for any other purpose except distillation. In 1937, it is estimated, the total yield of coal oil would be about 900,000 metric tons supplying about 50% of Germany's total requirements for petrol. The German Government, however, has decided to develop this industry till the country becomes practically self-sufficient.

In Japan, too, the strategical considerations have led the authorities to turn their attention to the coal-oil industry. The first big Japanese plant started working in 1935 in Manchuria. Within seven years Japan wants to be self-sufficient to a great extent in her supply of petrol and heavy oil. In 1943 Japan's total requirements are expected to be 4,910,000 metric tons out of which 2,000,000 tons are to be produced from coal. The huge capital which will be required to finance the project will be supplied jointly by the Japanese State and the Japanese industry.

In England, as our readers are already aware, a hydrogenation plant was opened by the Imperial Chemical Industries at Billingham with State aid. It is expected to produce 150,000 tons of oil this year. Compared to the plans of Germany and Japan, the British production is rather modest, meeting only about 4% of the country's total need. The low temperature carbonization industry, however, showed good progress.

Discovery of Cannons with Inscriptions

According to an *A. P.* message, a ploughman, while tilling his land in the Upper Dehing Reserve, East Block (some seven miles from Margherita in Assam),

brought his ploughshare in contact with a hard substance, which was found to be a cannon. The matter was brought to the notice of the local Forest Ranger, who caused the cannon along with another lying nearby to be brought to Margherita. The cannons measure 4′ 6″ and 3′ 8″ in length with circumferences of 1′ 8″ and 3′ 8″ respectively and weigh 3 maunds and 21 seers, and 2 maunds and 14 seers respectively. The importance of the discovery lies in the fact that the cannons bear inscriptions in Assamese and Urdu which when translated run:—

"In memory of the glorious valour of Raja Gadadhar Singh (Ahom King) and Sri Sri Surjanarayan Dev (Kochraj, Cooch Behar) who defeated the *Javans*—1604 Śakabda." By *Javans* it is presumed that it refers to the defeat of Mirjumla by these Kings in Kamrup.

Santal Dictionary

In the course of a speech communicating the news of the completion of Mr Bodding's Santal Dictionary to the Royal Asiatic Society, Mr Johan van Manen, the General Secretary of the Society, said that until recent decades the lexicographical treatment of the many languages of India was with one exception rather primitive. The one exception was the great Sanskrit Dictionary by Böhtlink and Roth, published in St Petersburg in seven gigantic volumes, from 1855 to 1875. None of the vernaculars, until quite recently, show anything comparable to that work. Of late a great improvement has taken place, though in certain cases bulk and methodical treatment have not been commensurate. In 1925 Stede's Pali-English Dictionary became complete, in 1931 Turner's Nepali Dictionary and in 1932 Grierson's Kashmiri Dictionary. For several vernaculars extensive and detailed dictionaries are in course of publication.

Last year P.O. Bodding completed his Santal Dictionary, a monumental work in five volumes, containing over 3,400 large octavo pages. The nucleus of the material had been collected by Skerfsrud before 1890 when Rev. Bodding arrived in India to work amongst the Santals as a missionary. In about 1905 he had increased the number of words from an initial 13,000 to about double that number. From 1905 regular work on the dictionary had to be laid aside for about 20 years but in 1924 the work was taken up again and became the author's principal occupation. From 1924 to 1934 the dictionary remained Mr Bodding's main preoccupation. During that time Mr Bodding had not only been speaking Santal language daily but had studied it with the greatest care. In 1903 he had provisionally finished the translation of the Bible into Santali. Notwithstanding his thorough knowledge of the language the author took the greatest care to ensure the reliability of his data, so necessary in the case of a practically unwritten language. When working on the dictionary he had always Santals sitting with him, never less than three at a time. These, the author says, were intelligent men with experience and knowledge of the people and their customs. The author is a linguistic scholar of great gifts, quite apart from his specific knowledge of the Santal language. He has been at pains to indicate the possible correspondences with other Munda idioms. The dictionary is exceptionally rich in its record of idiomatic expressions and combinations. Throughout the work a wealth of information of ethnological interest is to be found and a special index to the relevant headings is added to the work. With this life-work of over 40 years' duration, terminated by the issue of the last volume in 1936, Mr Bodding has erected a monument to himself and produced a linguistic document unrivalled for any Indian aboriginal idiom.

Improvement of Indian Museums

The Markham and Hargreave report on Indian museums has revealed beyond doubt the utter backwardness of museums in India both in number and in quality. We have editorially reviewed this report in our last July number and discussed the gradual evolution of the museum ideals from the stage of curio-collecting to the modern conception of an active institution of instruction. It is a happy sign that the Government of India authorities are now contemplating to take some active steps in the matter.

It is reported in the press that the authorities are planning to hold a conference next winter in Delhi to discuss the improvement of museums in India. This is a most important step and elsewhere in this issue we publish the comments of Dr Sitaram, the curator of the Lahore Museum, on the proposed conference.

NOTES AND NEWS

Plans for improving the Indian Museum in Calcutta are particularly in hand. The exhibits will be rearranged in such a manner that the layman may have no difficulty in understanding them. The old fort at Delhi may be used to house a Central Museum and the Central Asian Museum will be shifted there from its present site and considerably extended.

An enquiry committee some time ago discovered that in the famous Elephanta Caves near Bombay salt water was percolating and eating up parts of the cave's temple. On considering this report the Government of India have decided to undertake the restoration work immediately. A sum of Rs. 2 lakhs may be granted for the purpose. The restoration work will include the washing out of salt, cementing the cracks and realignment of the drainage from the main hall where one of the pillars has been badly damaged.

It is further understood that the Government of India have decided to send one of the superintendents of the Archaeological Department to Europe. He is expected to visit London, Paris, Rome, Berlin and Vienna to gain knowledge of the curatorial methods at these centres. On his return, it is proposed to place two Indians under him with scholarships for receiving the necessary training at the Central Government's museums at New Delhi, Calcutta, and Taxila.

All-India Institute of Hygiene and Public Health

A Press Note of the Government of India gives an account of the work carried out at the All India Institute of Hygiene and Public Health, during the year 1936.

Cholera

Side by side with basic researches there were interesting investigations bearing on public health problems of the country. One such problem was cholera, which has made Bengal its home from where big epidemics occasionally spread over vast areas in India and beyond. The causes of endemicity of cholera in Bengal were investigated both in the laboratory and in the field, and in these investigations other research laboratories too gave active co-operation. Statistical analysis of recorded cholera mortality in different parts of Bengal has shown that the incidence of the disease is not uniform throughout the Province. Certain areas have been found to be highly endemic. In one of these areas continuous field observations were carried out and a large amount of information was collected, the analysis of which, it is hoped, will clear up certain important points in regard to the cholera problem. Statistical studies were also carried out with a view to develop a method of forecasting cholera epidemics so as to forewarn the public health authorities. In addition, there were basic researches into the chemical constitution of cholera vibrio in relation to the virulence of the organism, and important results have been obtained. Attempts have also been made to find simpler methods to determine the chemical constitution of these vibrios.

Epidemic Dropsy

Epidemic dropsy is another disease which received special attention. The controversy regarding its etiology dates back to 1877, and many theories have been advanced, but none of them have proved entirely satisfactory. Intensive field investigations carried out in Assam, Bengal and Bihar have indicated that certain samples of mustard oil may be to blame. As a result of a series of control experiments including experiments on human volunteers, it has been strongly suggested that certain supplies of mustard oil contained a substance which may be responsible for the production of symptoms of epidemic dropsy. While it is possible that the term epidemic dropsy is at present loosely used and covers more than one disease condition, much can be done, says the report, to prevent development of the disease by preventing the distribution of mustard oil of this kind. The nature of the poisonous substance and the source from which it is derived is at present under investigation. The problem is as yet by no means solved.

Nutrition

The problems of nutrition which are now very much before the public eye were also investigated in certain aspects. A large number of common Indian foodstuffs were examined for their salt and vitamin contents, particular attention being given to vitamin B. Nutrition surveys for the determination of the quantity and quality of food and nutritional

status of the children were carried out in certain institutions at Calcutta and at Ferozepore in the Punjab. It was found that the main deficiency in the diet was the lack of good types of protein and of certain salts, and that this defect in the dietary, which could be corrected by milk, was associated with the poor physique of the children. The caloric value of food required by Indian children was found to be the same as that required by English children. Studies were also made on the relation of cataract to vitamin B defect and on certain chemical properties of blood in relation to anaemia and other diseases. A fact of great importance which emerged was the desirability of combining fat and if possible meat with food containing green vegetables and carrots. These foodstuffs are rich in a substance called carotene, which is the main source of vitamin A in India, while fat helps in the absorption of carotene and meat in its conversion into vitamin A.

Malaria

In the Malaria Section attention was chiefly given to investigations into black water fever, which occurs in certain highly malarious localities. Black water fever is a highly fatal affliction but unfortunately scientists are still in the dark as to its causes and its treatment. Studies of a similar condition in monkeys show that it was caused by paucity of the balance of certain chemical constituents of blood due to lesions in the liver and the adrenal glands. Partial success in the treatment of the disease in many cases was obtained by basing treatment on these findings. Investigation of the disease was extended to human cases and promising results were obtained. Other malaria problems studied included investigations into the part played by certain important malaria carrying species of mosquitos and the spread of malaria in Bengal and certain basic studies on malaria parasites. Experiments were also conducted to test the claims made by the inventors of the Entoray machine for its efficiency in killing mosquitos, but the claims could not be substantiated.

Miscellaneous

Intensive studies were also made into the problem of tuberculosis, and among other points brought out by these studies there was one which demonstrated the danger from exposure of contacts specially of children to open cases in the family.

Loss of life associated with maternity was another subject investigated. The results obtained should give food for thought to social workers and particularly to those who are interested in the well-being of mothers. It was found that in 94 per cent of deaths due directly to child-bearing, a primary avoidable factor was present, the main cases of maternal deaths being due to infection arising out of uncleanliness during childbirth, poison in the system and accidents of labour.

Apart from research, training is another aspect of its activities in which the Institute presents an interesting record of progress. It may be noted that the Institute provides advanced training for public health workers on an all-India basis. The principal course of training offered by the Institute leads to the Diploma in Public Health of the University of Calcutta and Diploma in Public Health and Hygiene of the School of Tropical Medicine and Hygiene, Bengal. In this training the School of Tropical Medicine takes an important part. Admission has to be restricted to 30 students on account of limited laboratory accommodation. In previous years some of the seats remained vacant, but a noticeable feature of the year under report was that there were 74 applicants of which 26 were admitted for D. P. H. and 5 for D. P. H. and Hy. Students came from all Provinces of India except Sind and Orissa, and 15 were employees of the Central and Provincial Governments, local bodies or Indian States.

It may be recalled that the Institute was established with funds provided by the munificent donation of Rs. 17.87 lakhs from the Rockefeller Foundation of the United States of America. But the responsibility for its maintenance was undertaken by the Government of India. Unfortunately, however, the opening of the Institute coincided with a period of acute financial stringency, and thus the full development originally contemplated had to be deferred. As a result, four sections dealing with public health administration, Malariology, Biochemistry, Nutrition and Epidemiology and Vital Statistics have been functioning for the past four years, and the two sections on *Sanitary Engineering* and *Maternity* and Child Welfare were kept in abeyance. With a return to improved financial conditions, the Govern-

ment of India who have all along been conscious of these outstanding needs of the Institute have added to it the two new sections on Sanitary Engineering and Maternity and Child Welfare from April 1937.

Woodhouse Memorial Prize

The Director of Agriculture, Bihar, has sent us the following notice for publication:

In memory of Mr E. J. Woodhouse, late Economic Botanist and Principal of Sabour Agricultural College who was killed in action in France in 1917, a biennial prize in the form of a Silver Medal and books of a combined value of Rs 100|- will be awarded to the writer of the best essay on a subject to be selected from the list noted below. The length of the essay should not exceed 4,000 words.

The competition is open to graduates of Indian Universities and to Diploma holders and Licentiates of recognized agricultural colleges in India who are not more than 30 years of age on the date of submission of their essays.

Papers should be forwarded to the Director of Agriculture, Bihar, Patna, before the 30th November, 1937.

Failing papers of sufficient merit no award will be made. Essays must be typewritten on one side of paper only.

LIST OF SUBJECTS

1. Hybrid vigour in plants and its significance in plant breeding and agriculture.
2. Agricultural problems of the Indian Sugar Industry and their solution.
3. The importance of purity and equality of seeds of farm crops and how to prevent their deterioration.

Bt-Col. R. N. Chopra

We wish to offer our hearty congratulations to Bt-Col. R. N. Chopra, C.I.E., K.H.P., M.D., (*Cantab*), M.R.C.P. (*Lond.*), I.M.S., Professor of Pharmacology and Director, School of Tropical Medicine, Calcutta, on his recent admission to the degree of Doctor of Science of the University of Cambridge. By this award, the University has honoured one of her old alumni from India. Prof. Chopra is well-known in medical and scientific circles all over India, and needs no fresh introduction to our readers. He is Professor of Pharmacology and Director of the School of Tropical Medicine. A large number of researches on Indian indigenous drugs have emanated from his laboratory and the report of the Drugs Enquiry Committee, of which he was chairman, is considered to be an authoritative publication on the subject of control and standardization of drugs in the Indian market. We wish him unqualified success in his new venture of standardizing drugs and checking drug adulteration in India.

Sir Syed Ross Masood

We regret to have to announce the recent death of Sir Syed Ross Masood, Education Minister of Bhopal State and ex-Vice Chancellor of Aligarh Muslim University. He was forty eight years of age at the time of his death. He was an eminent scholar and educationist.

Dr. K. P. Jayswal

The death occurred of Dr K. P. Jayswal on August 4 last at Patna at the age of sixty six. He was a wellknown scholar of indology and was the editor of the *Bihar and Orissa Research Journal*. He was a past president of the All India Oriental Conference.

Announcements

Following the recommendations of the Irvine Committee, Sir C. V. Raman has ceased to be the Director of the Indian Institute of Science, Bangalore, but will continue to be Professor of Physics for another ten years on a monthly salary of Rs 2,500|-. Pending the appointment of a new Director, Rao Bahadur B. Venkatesachar will act in that capacity. Mr C. E. W. Jones, Retired Director of Public Instruction, Central Provinces, has been appointed to the newly created post of the Registrar of the Institute, who will look to the administrative side.

Dr K. R. Kanungo, Reader in the Department of History of the Dacca University, has been appointed Head of the Department in place of Dr R. C. Mazumdar appointed Vice-Chancellor of the University.

Science in Industry

New Industrial Processes developed in U. S. A.

A recent number of the *Chemical Age* gives an interesting account of a large number of new industrial and chemical processes which are now being developed in the United States. We give below a few of the most interesting ones:

A process has been invented for cleaning and degreasing wool by passing it through a refrigerated chamber. The layer of grease on the hairs is thus made friable and becomes detached from the wool, carrying away the dirt, which normally lies on the surface of the grease.

Experiments are being made with the manufacture of buttons, buckles, table tops and numerous other plastic articles from constituents of the soya-bean.

Radical departure has been made in permanent magnets by the use of a 65 per cent iron, 25 per cent nickel, and 10 per cent aluminium alloy to which may be added manganese, vanadium, cobalt, chromium, tungsten, molybdenum, or copper, giving a coercive force of 500 oersteds in combination with a residual induction of 9,500 gauss.

A new process has been specially developed to effect a case penetration of 14 per cent silicon in steel objects for chemical equipment, machine parts, bolts, nuts, etc. to render them non-corrosive against hot and cold hydrochloric and sulphuric acids, wet chlorine gases, salt-spray, etc. Its chief advantage is to give articles made from a cheap base metal the acid resisting properties of expensive stainless steel or the effectiveness of high silicon irons.

A new source of aluminium from the mineral alunite, instead of from the usual bauxite, is being developed. In the light alloy field, the structural application of aluminium to large engineering constructions such as railway coaches, cranes, bridges, ships, etc., is making substantial progress.

Selenium, a member of the sulphur group of elements, is a by-product from the lead refineries. It is being used extensively in the tyre industry to improve the wear resistance.

Potassium Salts from Molasses

Annual production of potassium salts from molasses residues at the plant put into operation by L'Appula Soc. Anon., in Italy, in 1935, is now reported to be 4,000 tons. The range of salts produced includes chloride, sulphate, bicarbonate, hydroxide, and metabisulphite.

Electrical Developments in Madras

A recent note in the *Statesman* gives a brief account of the plans of the Madras Government for the development and expansion of electrical projects.

The most important work now in progress is the second stage of the Pykara Hydro-Electric Scheme. The Mettur Hydro-Electric Scheme has, from the middle of July, been supplying power with one unit, while the Vizagapatam and Bezwada thermal stations are in course of construction. The Papanasam Hydro-Electric Scheme, which is expected to cost about two crores of rupees and a scheme for pumping water from bore holes for the famine-affected ceded districts, are also under consideration by the Government.

The second stages of the Pykara Scheme comprising the construction of the Mukurti dam, is almost complete and work in providing additional units at Pykara has been in progress since April last. The Mukurti reservoir will impound 1,430 million cubic feet of water and has been constructed at a cost of Rs. 21¼ lakhs. An additional pipe-line for the Pykara plant, of larger dimensions than the present ones, is being set up. It will feed two large turbines of 15,800 h.p. each. This will cost about Rs. 35 lakhs, and is scheduled to be completed by 1938.

Later, the Moyar site below the Pykara power house will be developed, constituting the third stage of the Pykara Scheme. Thus the Pykara site alone

is capable of producing more than 100,000 h.p., and with the completion of the second stage it will be possible to generate about 60,000 h.p.

On account of the extensions of power to the Trichinopoly and Negapatam districts, not foreseen when the estimates for the first stage of the Pykara Scheme were prepared, the limit of the present plant has been reached, necessitating the construction of the second stage. Since the middle of July the Mettur Plant, with one unit working, has been able to supply power up to Negapatam and Vellore. Further transmission lines, under the Mettur system, are being completed.

Prospect of Chemical Industry in India

This month we are publishing in this section an article on "Some Aspects of Chemical Industry in India" by K. L. Roy of the Department of Applied Chemistry, Calcutta University. It is only too well known that a huge amount of wealth flows annually from India to more advanced countries of the West by our export of raw materials and import of manufactured goods. Mr Roy has supplied exhaustive figures and facts which help us to form an idea of the magnitude of this drain. The author also puts forth a strong plea for the establishment of chemical industries in India for many of which all the necessary raw materials are available in our country.

Glass Industry in India

Also, there appears a short article on Glass Industry in India. Various criticisms have been offered from time to time about the activities of the Industrial Research Bureau, and these have appeared in most papers. Here in this article some of those which seemed to us scientifically important and quite legitimate have been mentioned with a view to draw the attention of all those who are interested in the improvement and expansion of the Glass Industry in this country, especially the Government and the Industrial Research Bureau.

Some Aspects of Chemical Industry in India

Kanai Lal Roy
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Industry, as is well known, is at the root of the wealth and prosperity of a modern community. Industry, as it is understood to-day, with all its numerous branches, was not known a few centuries ago, and trade then consisted mainly in the import and export of raw materials from one country to another. With the advent of the modern scientific era, when people began to learn how by application of science these raw materials could be turned into new, useful and fine products, an unseen but all-pervasive supremacy in the line of industry was gained by the scientifically skilled nations over others, which were scientifically backward. These latter countries, thus, ultimately became the chief exporters of raw materials at nominal prices and consumers of the finished articles imported at exorbitant rates. In this way a continuous drainage of wealth from one country to a more scientifically advanced country became possible, without causing much perturbation amongst the people, who were being thus impoverished. Yet it must be easily understood that this type of exploitation through the agency of modern scientific industries is really more devastating in nature than the ordinary invasions, for instance, to which India had

been long subject. This exploitation, bloodless but most insidious, can be stopped only by a conscious and planned adoption of the scientific and industrial way of life. The weapon, therefore, is not the sword but thorough scientific and industrial training in the country, so that India's vast resources of raw-materials could be converted into finished goods in the country itself. The establishment of scientific industries must be encouraged and steadily fostered. In our country where the annual exports of merchandise (which comprise over 99% raw materials) are estimated at more than 160 crores of rupees, and annual imports of articles (most of which are derived from chemical industries) at over 130 crores of rupees, the establishment of chemical industries has now become an immediate necessity.

With the progress of chemical researches in various branches, and their subsequent applications in industries, the chemical industry of to-day has become a vast and very complex subject. Unlike other industries the chemical ones often require some special technique in the manufacturing process, which is known only to the technical experts and chemists. These industries, therefore, particularly require the assistance of those who know the technique well.

The industries of our country where huge capitals are invested are the following: -

1. Jute and Cotton. 2. Paper. 3. Iron and Steel. 4. Sulphuric Acid and Ammonium Sulphate. 5. Petrol and Kerosene Oil. 6. Portland Cement. 7. Sugar. 8. Matches. 9. Wheat and Flour. 10. Distilleries and Breweries. 11. Paint and Varnish.

If we look into the statistics we will find that our demand for many imported articles is constantly increasing; this shows that many small industries are growing within the country. But these infant industries now depend on the foreign manufacturers for their raw materials. It is therefore unwise not to start some new chemical industries which are basic in nature, as, otherwise, in an international crisis these smaller industries will have a severe set-back.

The following is a list of some important imported articles, and as most of the raw materials for their manufacture can be obtained in our country there is no ground why attempts should not be made to start the manufacture of these articles:—

Articles	1935-36 (in cwt.)	Value (Rs. in lakhs)
Artificial silk		316
Aluminium	63,500	45
Brass	509,500	135
Copper	417,000	117
Lead	27,600	5.1
Tin	53,100	78
Zinc	454,000	46½
German Silver	27,400	15½
Quick Silver	421,000	9
Rubber Goods		207
Chemicals		312
Sodi Carbonate	1,253,000	62
Caustic Soda	406,000	41¾
Calcium carbide	66,700	7
Copper Sulphate	35,220	4.4
Bleaching materials		12
Starch and Dextrin etc.		35
Patent medicines and Drugs		64
Mineral Oil		592
Dyes		334
Glass and Glass Ware		139
Paints and Painter's materials		101

The consumption of liquid fuel in our country has considerably increased as our annual import figure is approximately 6 crores of rupees, in spite of the fact that the total production of petrol and kerosene in India and Burma in 1935-36 was 162.4 million gallons. This shows that there is a good demand for liquid fuel. It is, therefore, worth while investigating processes of low-temperature carbonization of coal and other methods, so that we may recover most of the tar as liquid fuel and use it in place of petroleum oil.

In India there are vast deposits of minerals and ores, but except the iron and steel industry there are no other metallurgical industries worth the name. Our annual import of metals other than iron and steel is worth about 5 crores of rupees.

Rubber is another industry of importance. We buy over 2 crores of rupees of rubber goods. But rubber is grown mainly in Southern India and Burma. The export of rubber by sea from India to foreign countries during 1935-36 amounted to 34.7

million pounds, of which the United Kingdom absorbed major portion.

Now it is time that India should undertake some basic industries like alkali, calcium carbide, metallurgical industries, glycerine, starch and dextrin, artificial silk, coal-tar dyes, etc., so that many minor industries within the country will get internal support and will not die out even during war for want of raw materials.

One of the greatest difficulties that we experience in a manufacturing process is the want of suitable and efficient machineries and other appliances. We always depend on foreign manufacturers for those machineries. It is not always possible to place order from India abroad for a particular piece of machinery which may be very urgently needed, as it would involve unnecessary expenditure and loss of time. So it is a very important point that if we want to develop our chemical industries in our country we should simultaneously try to develop our mechanical and electrical workshops with up-to-date standards and equipments. Our annual import of machinery and mill work is Rs. 13,38 lakhs. A list of the imported machinery and millwork with their approximate value is given below:—

TABLE I

Machinery and Millwork (Rs. 13,68 lakhs)
(In lakhs of rupees)

	1929-30	1931-32	1932-33	1933-34	1934-35	1935-36
Prime movers	412	156	100	121	144	157
Electrical	241	216	156	127	169	205
Boilers	109	56	45	66	44	76
Machine tools	36	19	15	16	14	18
Mining	61	66	38	32	52	41
Oil crushing and refining	43	35	19	27	21	22
Paper mill	7	6	5	11	9	8
Refrigerating	20	10	9	7	10	9
Rice and Flour mill	24	10	9	7	10	9
Saw mill	9	3	3	3	3	5
Sewing and Knitting	85	51	45	50	83	74
Sugar Machinery	9	30	153	336	105	66
Tea machinery	28	11	21	12	22	13
Cotton machinery	210	193	208	203	241	201
Jute mill machinery	144	32	36	32	54	116
Wool machinery	6	1	3	3	2	4
Type writers including parts and accessories	26	13	7	10	18	19
Printing and Lithography Presses	23	15	9	15	15	17
Belting for machinery	90	50	53	46	50	54

(In lakhs of rupees)

One would be astonished to learn that India consumes over 8 crores of rupees of provisions, which include biscuits, cakes, canned and tinned foods, etc. A list of these articles is given in the following:—

TABLE 2

Articles	1935-36 (in cwt.)	Value (Rs. in lakhs)
Biscuits and cakes	5,47,00	36
Canned and bottled provisions		65
Tinned or canned fish	64,100	14
Canned and bottled fruits	43,300	11
Vegetable ghee		$1\frac{2}{3}$
Milk food for infants and invalids and other patent foods	10,400	$16\frac{1}{2}$
Condensed and preserved milk	209,200	54
Jams and Jellies	20,000	7
Confectionary		18
Pickles and chutnies and sauces	10,800	7
Bacon and ham	17,000	$12\frac{1}{2}$
Butter	7,700	7

Here also is a vast field open before the chemists and inhabitants of this country.

Besides all these there are many other minor industries which can be established in this country. They are, for example, electro-plating, dyeing and

bleaching for fabrics, preparations, manufacture of disinfectants, ink, metal polishes, manufacture of carbon blocks, preparation of some chemicals like copper sulphate, sodium sulphide, alum, permanganate, di-chromate, etc., which have good markets; toilet products; manufacture of photographic chemicals and plates; preparation of some fine chemicals, etc.; and these industries cannot develop without the assistance of chemists. It is evident that with the gradual development of chemical inlustries in our country our chemists as also thousands of others will receive employment in these industries.

The accompanying table, which shows the comparative importance of the principal articles imported into British India (Table 3), may be of interest.

The development of chemical industries in a country depends on (*a*) the cheap supply of raw materials (*b*) the cheap supply of power and lastly (*c*) the local conditions. Conditions for many manufactures are favourable in this country. So far as industries, which require special climatic conditions, are concerned, one should not forget that by modern scientific means it is now possible to change many local conditions. The technique of air conditioning, artificial cooling and heating have developed to such a degree of perfection that it is not at all difficult to modify any local condition according to the requirements of an industry. It is high time that our capitalists should come forward and invest capital for the establishment of basic chemical industries, as, otherwise, these industries are bound to be started sooner or later in our country under management of foreign financiers. The raw materials are there, in most cases the technical knowledge is there and much capital is at present idle. At present it is only co-operation betwen the capitalists and experts that is needed for the establishment of important chemical industries in India.

Glass Industry in India

Glass Industry in India is of comparatively recent growth and is still a small industry. In order to attain greater importance, it requires not only the support from the public but also Government patronage and backing which alone can save it from hard foreign competition that tends to stifle every indigenous industry. But unless the steps that the Government take or propose to take are conducive to a greater prosperity and quicker improvement of the industry, not much good can come out of it. The Industrial Research Bureau of the Government of India now claims to devote its attention to the glass industry. Its anual report published recently is not however very hopeful as far as this industry is concerned. "The importance attached to the development," says the *Government Communique*, "Of the glass indusary in India is indicated by the allocation of a complete chapter to the work carried out in connection with problems of this industry. An improved pot type of furnace has been designed to operate with considerable reduction in fuel consumption and to give higher temperature which will enable the costly soda-ash content of glass to be reduced, and arrangements have been made for the installation of a demonstration furnace of this design in a Glass Works at Firozabad, the well-known centre of the glass industry in the United Provinces. Investigations are also being conducted with a view to assisting the glass bangle industry. Valuable work on the locating of deposits of raw materials suitable for use by the glass industry and their grading by means of analyses and testing of samples is in progress."

Since it was published, the report has been commented on by various individuals interested in the glass industry. We quote below somewhat in detail the criticism levelled against it by one of the most prominent persons of this industry in India:—

"I have just glanced through the Annual Report of the Industrial Research Bureau recently released to the public and I cannot but express a keen sense of disappointment at the results of the Bureau's research activities in connection with the glass industry.....After laborious researches during more

than a year and a half, the Bureau is going to present us with an experiment in a better type of furnace at Ferozabad in U. P. which specializes more in the manufacture of bangles than in other varieties of glassware. We have been denied the advantage of protection which our languishing glass industry badly requires against foreign competition and now we are going to have an experiment to be carried on far away from the chief centre of the industry and for reasons which would not bear a moment's scrutiny.

" The report of the Bureau informs us that 'an advanced pot type of furnace has been designed to operate with considerable reduction in fuel consumption and give higher working temperature which will enable the costly Soda-Ash content of glass to be reduced.' But I have definitely come to know from a Director of an established glass manufacturing concern who has just returned from a business tour in Japan that proportion of Soda Ash prescribed by the Japanese standard formula for glass manufacture is almost the same as in our country. The low cost of the Japanese industry must be due to some other causes but here in India the effort to secure economy by reducing the Soda Ash content in glass seems to be misdirected and is not likely to pay after all.

" This is in fact all the response which the Government of India has been pleased to vouchsafe to our persistent entreaties for protection and other forms of assistance to the glass industry. The industry languishes and succumbs but the Government is sitting complacent over a research organization that has taken about two years to hatch a plan of experiment of dubious utility."

We fuly agree with Mr Sen and endorse the points of criticism raised by him in the above statement.

There is another point which requires mention. The subject of scientific glass apparatuses and various other laboratory requisites has not yet engaged the attention of the Bureau, and it looks as if glass industry in India is synonymous with the manufacture of bangles. Whatever little is being done by the native factories in this case must be supplemented and improved by the Bureau which stands for the purpose.

Alkaline-free glass materials form one of the indispensable commodities for use in the laboratories; but unfortunately this branch of the industry has failed so far to engage the attention of the Bureau. An up-to-date factory for these articles should be a paying concern but until and unless built on a scientific basis neither the quality could be improved nor would the producers be able to compete with the imported articles. This is what can never be brought within the range of practicality without the active support and sympathy of the Government of the country.

It is hoped however that the Research Bureau will yet find it worth while to consider this most important aspect of glass industry in all its bearings, and do something by way of recommendations and suggestions that would ensure a march ahead of the small concerns dealing in none-the-less important branch of this industry.

Continued from page 158

his *History of Hindu Chemistry*. But the dearest thing he cherishes is the school which he has created to hold aloft the banner he unfurled. Prafulla Chandra has truly been a nation-builder. He is one of those great men who work ceaselessly, in the words of the poet,

"To turn the clod
To a thing divine
The earth a shrine
And Man the God."

B. C. G.

Research Notes

Heat of Vaporization of Elements with High Melting Points

Heat of vaporization of elements is a quantity very often required in thermochemical and photochemical calculations. The method for this determination consists in measuring the vapour pressure of the substance at various temperatures and then applying the well-known thermodynamic relation $\lambda = 4{\cdot}571 \frac{T_1 T_2}{T_2 - T_1} \log \frac{P_2}{P_1}$, where λ is the latent heat of vaporization and P_1 and P_2 are the vapour pressures at temperatures T_1 and T_2. This simple relation though sufficiently accurate at fairly low temperatures does not yield good results for substances at high temperatures on account of the difficulty in measuring the vapour pressure at those temperatures. Langmuir modified it and replaced it by the relation $\lambda_0/T = A - B \log T - \log ma - DT - E/T$ [*Phys. Rev*, *30*, 206, 1927], where λ_0 is the latent heat of the substance at 0° Abs, A, B, C, D and E are parameters depending on various atomic and gas constants, and m is the rate of evaporation of the substance given by the relation $m = p\,[M/2\pi RT]^{\frac{1}{2}}$ where M is the molecular weight, p the vapour pressure at $T°$ Abs, R the well-known gas constant [Langmuir: *Phys. Rev.* *2*, 329, 1913]. With the help of these relations Jones, Langmuir, and Mackay found out the heats of vaporization of W, Mo, Pt, Ni, Fe, Cu, and Ag having boiling points of 6970°, 5960°, 4800°, 3650°, 3475°, 3110° and 2740° respectively. Their values for the heat of vaporization were 191880, 146000, 127500, 89440, 89000, 82000 and 71320 calories per gram atom respectively [*Phy. Rev. 27*, 201, 1927]. These values require confirmation from other independent sources to test the validity of Langmuir's relations. Marshall and Norton experimented with graphite [*Journ. Amer. Chem. Soc. 55*, 431, 1933]. In the case of graphite the vapour pressures obtained in this way yielded a heat of vaporization much higher than that calculated from spectroscopic data. In view of this disagreement it seemed desirable to test the validity of Langmuir's method of determination of vapour pressures from the rates of evaporation of elements by comparing with those of reliable equilibrium vapour pressure measurments. Harteck had published the result of such measurements for copper (*Zs. Physikal. Chem.*, *134*, 1, 1928) and evaluated the heat of vaporization from his vapour pressure data. Marshall, Dornte and Norton thus found in copper the suitable element by experiment on which the validity of Langmuir's theory could be ascertained. These investigators heated rings of copper and iron of known surface area by high frequency induction furnace in a high vacuum at accurately determined temperatures and measured the rate of evaporation of these metals for known time intervals. From this rate of evaporation of the metal they calculated the vapour pressure with the help of Langmuir's relation. Their mean values of λ_0 for temperatures ranging from 1300°K to 1600°K for copper is 80709 $\pm$ 600 cal/g. atom and that for iron 96033 $\pm$ 310 cal/g. atom. Harteck's value for copper was 81807 $\pm$ 300 cal/g. atom indicating the satisfactory agreement between the two methods (*Jour. Amer. Chem. Soc.*, *59*, 1101, 1937). In this paper it is also pointed out that there occurs a systematic trend in the λ_0 values for copper. The values for solid copper lead to a mean λ_0 of 81244 cal/g. atom while the values at the melting point and above give a mean λ_0 of 79853 cal per gm. atom.

S. C. Deb.

Chemical Reagent for Vitamin B_1

McColum and Prebluda report [*J. Biol. Chem. 119*, proceedings lxxix, 1937] that the derivatives

of aniline or naphthylamines after being treated with nitrous acid produce characteristic coloured solutions when allowed to react under certain conditions with vitamin B_1. Either *p*-aminoacetanilide or *p*-aminoacetophenone is suitable for the purpose. These reagents give purple-red compounds which crystallize readily, are stable, and are highly insoluble in aqueous medium in which they are formed. The crystalline coloured product obtained by the use of either reagent is readily extractable by acetone or *iso*-butyl alcohol.

Since the colour of the reaction product with these reagents is sufficiently sensitive to enable one to detect the presence of vitamin B_1 in amount corresponding to even one international unit in 1 c.c. of solution, the test has been made the basis of the quantitative assay of vitamin B_1 in biological materials and foodstuffs.

B. Ghosh.

Root-forming Skatole

Glover observed the activity of skatole as a growth-promoting substance. Recently Warner and Jackson [*Nature*, July 3, 1937] carried out experiments which showed that skatole accelerates root formation in cuttings of *Leptospermum scoparium* and *Ficus repens*. The simple method is to treat the cuttings with aqueous solution of skatole (20 mg per 100 c.c. water) for 6 hours and then the cuttings are planted in a mixture of cocoanut fibre and sand in a propagator. This treatment accelerated the root propagation. Nearly 60 to 70 per cent growth was observed in the skatole treated samples. Parallel experiments showed *l*-tryptophan to be inactive.

B. G.

The Discovery of a New Purine in Tea

Treat. B. Johnson [*J. Amer. Chem. Soc.*, July, 1261, 1937] reports the discovery of a new purine in tea. The tea residues left after the commercial removal of the alkaloid caffeine were treated with methanol to wash out yellow vegetable colouring matters. The residue was taken into solution by warming with methanol. After filtering and cooling slowly, hexagonal crystals were noted mixed with other substances.

The hexagonal crystals were mechanically separated with small tweezers and purified with difficulty by crystallization from boiling water. The new substance was characterized by its crystal habit, its sharp melting point and neutral character. After a careful investigation of the several colour-tests applicable for the detection and identification of specific purine and pyrimidine configurations, the author has come to the conclusion that this new substance occurring in tea residue is 1 : 3 : 7 : 9 : -tetramethyl - 2 : 6 : 8 - trionypurine. In fact, it is the first methylated derivative of 2 : 6 : 8 - trioxy purine (uric acid) to be discovered in nature and this purine derivative was first synthesized by Emil Fischer in 1884.

B. G.

Extraction of Hard Lac Resin by Means of Aqueous Solutions

In previous publications of the London Shellac Research Bureau the possibilities of improving the properties of lac or shellac were demonstrated. It has now been shown by R. Bhattacharya [*Chem. Ind*, *56*, 666, 1937] that certain solvents under suitable conditions could extract a major part of the soft resin component of lac, and the residual resin, which forms about 70%-80% of the total lac, possessed higher softening and melting points, did not "blush" or whiten when immersed in water, and did not attack copper. It has been shown that films of this hard resin component on baking had good adhesion and flexibility as well as increased hardness. As processes involving extraction with organic solvents are hazardous and costly, attempts have been made to find other processes of extraction. The possibilities of extracting lac in aqueous medium, first discovered at the Teddington laboratories in February 1936, have materialized in the last few months.

Aqueous solutions of alkali phosphate, borax, and sodium carbonate have been used successfully to extract lac resins. The dilution of these salts as

well as the quantity relative to the amount of lac under treatment extract varying quantities of "soft resin component". Though the acid value of the extracts vary with total percentage extraction, the acid value of the extracted "hard lac resin" remains practically the same in each case. It can be assumed, therefore, that the main component of lac has a definite acid value of approximately 55. A hypothesis which can explain the mechanism of extraction appears to be that the alkali salts of some components of lac resin of high acid value are first formed, which then peptize definite amounts of other components, depending on the dilution and other conditions. By using amounts of alkali insufficient to dissolve all the lac, any predetermined quantity can be extracted. The aqueous solution of the salt is taken in a suitable vessel provided with a mechanical stirrer. The temperature is maintained at 80°-100°C. and the lac is added. In an hour or so the peptized components are removed by decantation. The extracted resin is washed once or twice with hot water and dried. The "soft lac resin" can be recovered by acidifying the decanted aqueous extract.

It has been observed that the "hard lac resin" can be easily bleached with hypochlorite or ordinary bleached lac can be extracted by this process to give a white hard resin of low acid value and improved properties.

Formation of Lignin

Polymerization of formaldehyde into glucose and that of glucose into cellulose in the vegetable world are now established facts. But we have no such definite knowledge regarding the formation of lignin in plants. Comparatively fewer workers devoted themselves to the solution of this portion of the lignin problem. Some years back Wislicenus advanced the hypothesis that in the plant, glucose and fructose are formed simultaneously—while glucose is transformed into cellulose, fructose is converted into lignin. The most perplexing thing in lignin chemistry is the fact that lignins from different sources are found to behave differently. A general theory of formation of lignin can hardly explain this. The recent observations of Zherebov (*Bumazhnaya Prom.*, *15*, 27, 1936) has thrown some light on this problem. He finds that the accumulation of lignin in a plant tissue proceeds differently according to the physiological function performed by it. In young and old pine wood, the percentage of lignin is found to be constant, while in the case of cereal plants, the lignin constant increases continuously with age from nil to the normal value in a ripe plant. In conifers, in the early stage of growth, lignin is found to possess no methoxyl groups—the methoxyl value increases with maturity. This is contradictory to the views of Klason who holds that lignin owes its origin to coniferyl complex. Zherebov has detected sufficient amount of hydrocarbons with methoxyl groups in these plants, the quantity of which decreases gradually as the methoxyl value in lignin increases. According to Zherebov these hydrocarbons play an important role in the formation of lignin in plants. Obviously, larger number of plants of different types must be thoroughly studied with respect to the formation of lignin in the light of Zherebov's observations before a final theory can be advanced. The formation of these hydrocarbons as well has got to be adequately explained.

P. B. Sarkar.

University and Academy News

Anthropological Society

The annual meeting of the Anthropological Society was held on the 28th July, 1937, at 35 Ballygunge Circular Road, Calcutta, in the Anthropological Seminar, Calcutta University. The following officebearers were elected.

President—Mr K. P. Chattopadhyaya. *Secretary*—Dr P. C. Biswsas. *Asst. Secretary*—Mr K. H. Hossain. *Representative of the Ex-students*—Mr N. K. Bose.

Indian Chemical Society

An ordinary meeting of the Indian Chemical Society was held on the 23rd of July 1937, in the Chemistry Lecture Theatre, University College of Science, 92, Upper Circular Road, Calcutta.

Professor J. N. Mukherjee was in the chair

The chairman referred to the loss sustained by the Society through the death of Prof. Panna Lal of Science College, Patna, who was elected a Fellow in 1926. The chairman moved the following resolution :

The Fellows of the Indian Chemical Society offer their sincere condolence to the bereaved family of Prof. Panna Lal in their grievous loss. The resolution was carried standing.

The chairman presented the Sir P. C. Ray 70th Birthday Commemoration medal to Dr P. B. Sarkar who was considered to be the best candidate by the Board of Examiners appointed by the Council.

The following gentlemen are admitted as fellows :

1. Mr Charles H. Shirtcliff (Ishapore); 2. Dr Tarapada Banerjee, D. Sc. (Dacca); 3. Mr B. B. Chaudhury M. Sc. (Poona), 4. Prof. Andre Girardet, (Lausanne); 5. Dr S. V. Anantakrishnan M. Sc. Ph. D. (Calcutta); 6. Mr M. G. Kale, M. A. (Bombay).

The following gentlemen were elected as Fellows by ballot:

1. Lala Chetan, Anand, M. A. (Lahore); 2. Mr Champa Lal (Ludhiana); 3. Dr J. L. Sarin, M. Sc., Ph. D. (Lahore); 4. Dr A. N. Ghei, M.B., B. S., D. T. M., D. P. H. (Lahore); 5. Mr B. K. Menon, M. Sc. A. I. I. Sc. (Rangoon); 6. Mr Y. S. Gwan, B. Sc. (Rangoon); 7. N. K. Brahmachari, B. Sc. (Calcutta). 8. Dr A. N. Bose, Dr. Ing. (Calcutta); 9. Dr B. N. Pramanik, Ph. D. (Shahjahanpur), 10. Mr. B. N. Ghosh, M. Sc. (Calcutta); 11. Mr P. N, Sen Gupta, M. Sc. (Calcutta); 12. Mr M. Po Tha, M. Sc. (Rangoon); 13. Mr M. San Tun, B. Sc. (Rangoon).

On being requested by the chairman Dr P. B. Sarkar delivered the lecture on "The present state of our knowledge of lignin".

Dr P. C. Mitter, Dr J. N. Mukherjee, Dr S. V. Anantakrishnan, Mr M. A. Saboor, Dr D. Chakravarti, Dr B. C. Guha, and others took part in the discussion.

Letters to the Editor

A Comparative Study of Vitamin C in a few Germinated Oilseeds

Some time ago one of us[1] reported on the vitamin C content of germinated peas, estimated according to the titration method of Harris and Ray[2] as modified by Ghosh and Guha[3] and Guha and Ghosh[4]. Of late the existence of an ascorbic acid oxidase in many vegetable tissues containing vitamin C has been established. This enzyme oxidizes a part of the vitamin C in natural products even in course of its estimation by the above procedure. To obviate this deleterious effect of the oxidase, Mack and Tressler[5] have recently introduced a modification of the above method by the use of sulphuric acid in place of glacial acetic acid.

TABLE I.

Hours of germination	Mustard seeds (black) Brassica Campestris L	Mustard seeds (white)	Raisarisha Brassica Juncea Hook F	Sesame (black) Sesamum Indicum De	Sesame (white)
	0.182	0.288	No germination	No germination	0.054
48	0.390	0.236	0.088	"	0.094
	0.326	0.213	0.119	"	0.053
Average	0.299	0.268	0.103	—	0.067
	0.185	0.309	0.123	0.030	0.064
72	0.574	0.523	0.119	0.025	0.140
	0.280	0.276	0.153	0.020	0.087
Average	0.346	0.369	0.132	0.025	0.097
	0.313	0.435	0.115	0.056	0.140
96	0.672	0 532	0.270	0.024	0.104
	0.401	0 395	0.237	0.021	0.103
Average	0.463	0.454	0.207	0.034	0.116
	0.420	0.526	0.213	0.059	0.216
120	0.797	0.464	0.342	0.027	0.292
	0.329	0.589	0.216	0.024	0.176
Average	0.515*	0.526*	0.257*	0.036*	0.228*
	0.058	0.047	0.047	0.015	0.013
Ungerminated seeds.	0.065	0.064	0.040	0.016	0.016
	0.057	0.047	0.040	0.016	0.012
Average	0.060	0.053	0.042	0.015	0.014

In the present paper we have investigated the vitamin C content of the germinated oilseeds by making use of both

the methods. The tables given will show the difference in values for the different methods employed.

Clean, dry, mature seeds were first soaked in water for 3 hours. They were then placed in the folds of wet lint and kept in petri dishes. In most cases good germination took place in 48 hours. They were worked up for the estimation of vitamin C at intervals of 48, 72, 96 and 120 hours after they had been first soaked in water. 10g. of the germinated seeds were taken in a mortar with 2.5 c.c. of 20% trichloracetic acid solution and a few grammes of Merck's sea-sand. The seeds were finely ground with a few c.c. of distilled water and centrifuged. The centrifugate was made up to 100 c.c. and titrated against 2:6—dichlorophenol indophenol according to the method of Guha and Ghosh as mentioned above. Three sets of experiments were made with seeds from different sources and their average value was estimated. Dry weights of each sample of experimental seeds were determined and the amounts of vitamin C in mg. per gramme of the substance on the basis of dry weight have been recorded in Table I.

TABLE II.

Hours of germination	Mustard seeds (black)	Mustard seeds (white)	Sesame (white)	Sesame (black)
48	0.256	0.366	0.047	—
72	0.510	0.630	0.0125	0.049
96	0.667*	0.689	0.192*	0.050*
120	0.444	0.786*	0.138	0.035
Ungerminated seeds	0.089	0.106	0.023	0.022

TABLE IIA.

Hours of germination	Mustard seeds (black)	Mustard seeds (white)	Sesame (white)	Sesame (black)
48	0.313	0.397	0.060	
72	0.759	0.687	0.105	0.063
96	0.979*	0.909	0.226*	0.066*
120	0.450	0.978*	0.172	0.041
Ungerminated seeds.	0.115	0.133	0.024	0.024

In the second case the seeds were germinated in the usual manner and at each stage of germination two 10g. lots were taken out and the vitamin C content of one was determined: (1) by the above method, (2) by the modified method of Mack and Tressler in which 2 c.c. of 15% H_2SO_4 were used along with 2.5 c.c. of 20% trichloracetic acid solution during extraction of the vitamin. It should be noted that only one set of experiments has been done in this case. These results are given in Tables II and IIA respectively. The asterisks in the tables mark out the maximum value obtained with individual seeds investigated.

SUMMARY

From the tables it is evident that the white mustard seeds furnish the greatest while black sesame the least amount of vitamin C on germination. That enhanced values are obtained from Mack and Tressler's modification is apparent from Tables II A. Incidentally, it has also been noticed that there exists almost a direct proportionality between the growth-rate of the sprouts and the vitamin C content in the samples investigated.

Our sincere thanks are due to the authorities of the firm for their constant help and encouragement.

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26. 7. 37

1. SCIENCE AND CULTURE, *1*, 778, 1936
2. *Biochem. J.*, *27*, 303, 1933.
3. *J. Indian Chem. Soc.*, *12*, 30, 1935
4. *Current Science*, *2*, 390, 1935
5. *J. Biol. Chem.*, *118*, 735, 1937

Abnormal Spikelets in Paddy, Oryza Sativa Linn

In a field of Patnai paddy (Gosaba 23) at Gosaba, Sir Daniel Hamilton's Estate in the Sunderbans, plants were noticed with ears containing abnormal spikelet which at first sight looked like so many empty and opened spikelets. (Figs. 1, 2) The abnormality consisted of innumerable variations in the number of glumes, stamens and ovaries. The ears were collected and an analytical study of the range of abnormality was carried out in the laboratory. A statement is given below of the result of the analysis.

Tillers: There were altogether 20 tillers in the ears of which the range of variation of abnormal spikelet was from 34% to cent per cent. That is to say, there were ears with 34% as well as cent per cent abnormal spikelets, the normal spikelets were, however, also empty.

Spikelets: The normal spikelet of a paddy consists of the following parts:

(1) Two outer glumes.
(2) Two inner glumes.
(3) Six stamens.

(4) One ovary with a style and two feathery stigmas.

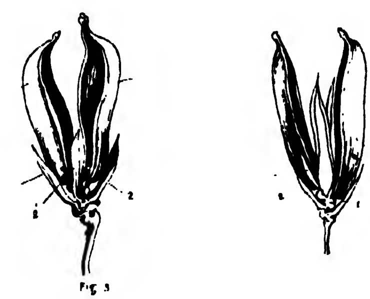
(5) Two lodicules at the base of the ovary.

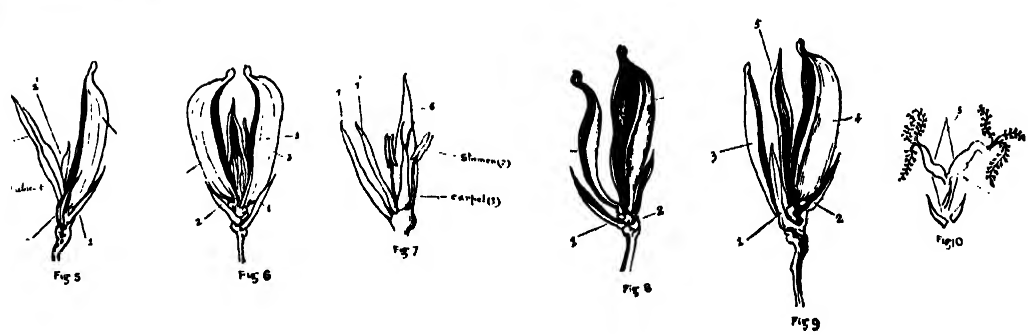
(i) The abnormality of outer glumes consisted both in number and shape. There were cases where 3 outer glumes were noticed. In such cases the glumes were of elongated and narrow shape (Figs. 3, 4).

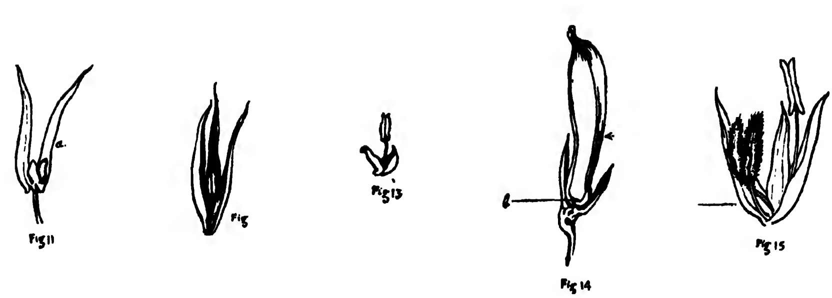
(ii) The most peculiar types of abnormality were observed in the number, structure and shape of the inner glumes. The number varied from single to as many as 5 (Figs, 4, 5, 6, 7). Structurally some of the glumes were just like normal glumes with prominent ribs, others were devoid of any trace of ribs and looked like cartilagenous outgrowth. (Fig. 6 gl. 5, Fig. 7 gl. 6 & Fig. 9 gl. 5). These glumes were usually of narrow and elongated shape. In certain cases they looked like split glumes having insertion

Fig. 1.

Fig. 2.







at the same line of the rachis of the spikelet (Fig. 7 gl. 7). In shape, though some of the 3rd glumes were of normal nature, yet most of the 4th glumes were very irregular having curved and reflexed appearance (Fig. 8, 9). Most probably due to this irregular shape of the inner glumes, they could not be fitted into one another to form a compact normal spikelet, and hence they remained open.

Stamens : In certain cases, the stamens were completely absent as though they were dioecious spikelets (Figs. 10, 11). In those cases where stamens were present, the number varied from 1 to 5 (Figs. 12, 13, 15). There was irregularity in the shape, size, and filaments of the stamens.

Ovaries : There were spikelets without any trace of ovary, though stamens were present (Fig. 12). In certain cases double ovaries were found with trifid stigma (Fig. 10). The latter kind of stigma were also present in the case of single ovary. The shape of the ovary was usually of elongated type with sowlen base (Figs. 7, 10). Lodicules were absent in most of the cases, but where they were present. the number varied from single to two (Figs, 11, 13).

Reports regarding the occurrence of such abnormal spikelets of rice plant is not frequent. Nagai (1924) mentioned about the occurrence of certain abnormality in the fourth and fifth generation of a cross. Although the present case of abnormality is not an exact replica of what Nagai had observed in his material, yet it may be said that there are certain similarities in the nature of the two cases of abnormality. In one case the abnormality of the spikelet consisted of the feather-shaped stigma transformed into three extra anthers which were mostly abortive but which occasionally produce healthy pollen grains, this mutant was called by him as stamioidal sterile. In this plant the pollination was naturally not possible, and the mutant form could only be kept as a staminate stock. It had happened therefore that a dioecious form had arisen from a hermaphrodite oryza. In the present case a dioecious form has arisen by complete absence of stamens in the spikelets.

In the second case of mutant the peculiar feature was that a certain number of spikelets produced more than one ovary, each of which had fully developed stigma. In the present case, spikelets with double ovaries were noticed.

In the third case, the plant appeared as secondary mutant from above-mentioned mutant, here the spikelets were abortive with a number of small, supernumery green glumes found within the regular glumes which were narrow. The anthers and ovaries were seldom formed but generally abortive. Consequently the mutants were completely sterile in both sexes. In our material there were several spikelets with supernumery glumes like the above, but less in number, the maximum number of glumes being 8.

Haigh (1936) reported a case of abnormality in the spikelets of rice from Ceylon. The abnormality was a clear case of chloranthy, in which all or the great majority of the organs of the flower became metamorphosed into leaves. Although the present case has not got the least resemblance with chloranthy yet mention of this abnormality has been made as it was also with spikelets of rice.

It is rather difficult to give a reasonable explanation to the occurrence of abnormality of the present case. Only two plants were found in a field of several acres of paddy. It might be a case of mutation, but the mutation was sterile as there was no full grained spikelets in any of the two plants.

Adverse growth condition may sometimes induce similar abnormal development of spikelets. Hori (1896) reported the occurrences of a widely distributed disease due to physiological causes. He considered that abnormal development is due to an excess of nitrogenous manure, influence of sewage water, sudden water supply after prolonged drought.

Yamaski (1923) also observed a similar anomaly in the shoots which were produced by the secondary growth of the remains after the harvest and which were kept in the green house throughout the winter. He considers that insufficient supply of heat in winter may be one of the chief causes.

Unfortunately in the present case the plants were noticed in their advanced age, when they were ready for harvest, so it was not possible to collect any data of their growth and environment. The root stock of the plants were however brought in the laboratory and were placed in the pot. After undergoing a period of dormancy for several months some tillers have come out. They are under careful observation for further study.

SUMMARY

A few plants with abnormal ears were found in a field of Patnai paddy (Gosaba 23) in the Estate of Sir Daniel Hamilton last December.

An analytical study of the abnormal spikelets was performed. The abnormality consists of innumerable variations in the number and structure of glumes, stamens and ovaries.

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8. 8. 37

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LETTERS TO THE EDITOR

The Determination of Total Nitrogen in Complex Nitrogenous Bodies

It is well known that the digestion by the usual Kjeldahl method in the determination of nitrogen of milk, blood serum and similar other substances containing complex nitrogenous compound takes much time, and numerous attempts have been made to shorten this digestion period. The use of selenium, alone or in combination with other catalysts, has been often found to be very advantageous and this with mercury, according to Poe and Nalder[1], or with phosphoric acid according to Cambell and Hanna[2], effects the greatest saving of time in digesting simple organic nitrogenous bodies. For about a year we are using selenium with yellow mercuric oxide (1:2) for the digestion of various nitrogenous compounds, such as milk, whey, lymph and other protein bodies. The above mixture saves much time and at the same time is found to be reliable and effective in our hands

The usual procedure is to mix the particular substance (2 c.c. in case of a liquid and 0.1 to 0.5 gm in case of a solid) with sulphuric acid, sp. gr. 1.84, (10c.c.), potassium hydrogen sulphate (5 gm), crystallized copper sulphate (0.5 gm) selenium (0.05 gm) and mercuric oxide (0.1 gm), and heat the mixture gently in a 50 c.c. Kjeldahl flask with a Teclu burner for about 5 minutes and then vigorously for about 5 to 10 minutes when a fine clear blue coloured solution is obtained. It is then allowed to cool and diluted with about 25 c.c. of distilled water. The solution, after cooling, is carefully washed into a 250 c.c. round bottom flask and the acid solution is made alkaline as usual. A few grams of sodium thiosulphate crystals (about one-fourth of the amount of alkali used) is added and the nitrogen is estimated in the customary way. The results obtained by this method did not differ appreciably from those obtained by digesting the same substance with a usual digesting mixture consisting of sulphuric acid (10 c.c.), potassium hydrogen sulphate (5 gm) and a trace of copper sulphate. The advantage of using the above catalyst is that the time required for obtaining a clear blue solntion varies from 10 to 15 minutes, whereas the latter and the usual method generally requires two to three hours for complete digestion. This obviously saves a great expenditure of time and fuel.

The details of the paper would be published elsewhere. In conclusion, we wish to express our sincere thanks to Dr U. Basu for his interest in these observations.

Research Laboratory,
Bengal Immunity,
Calcutta.
19.8.37

H. C. Goswami.
M. R. Ray.

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Obituary

MARCHESE GUGLIELMO MARCONI

Early in the morning of July 20, Marchese Guglielmo Marconi, the father of wireless, died of heart troubles in his house in Rome at the age of 63 years.

Guglielmo Marconi was born at Bologna, Italy, on April 25, 1874. His early life was not unlike that of a boy of average merit. There was not a single incident in his school days to show that the boy would one day become Marconi, the greatest name associated with the whole history of wireless. He was naturally shy and retiring; but he had a strong determination that enabled him to succeed in his crowning achievement at so early an age.

Marconi started his educational career at Bologna. He had a particular liking for electrical experiments from his very boyhood. When he grew older his interest in these experiments gradually deepened. He was not so well up in the theory of electricity as he was in the practical side of it. He performed with brilliant success each and every experiment he laid his hands on and almost always made far-reaching improvements in the details of the apparatus used by his predecessors. He was only a lad of 13 years when he heard of the experimental discovery of electromagnetic waves made by Heinrich Hertz in brilliant confirmation of the predictions of Maxwell's mathematical hypotheses. He was particularly attracted by the researches conducted by the Bolognese physicist, Augusto Righi, in connexion with these electric waves. He was not late in realizing that these waves might be conveniently made use of in transmitting messages from one place to another without the help of wires.

But his retiring nature at first prevented him from putting his hands on such an attempt. He successfully repeated every published experiment in connexion with the Hertzian waves but could not believe that he was alone in realizing the commercial possibilities of these waves. He therefore waited and watched for some announcement in the technical papers regarding the application of the Hertzian waves for practical purposes. Full one year passed by, but, to his astonishment, Marconi found that nothing of that kind appeared. He then made up his mind and started work at once.

His first experiments were performed in 1895 in his father's country house, the Villa Griffone, at Pontecchio. He installed his transmitter at one end of the garden and at the other end the receiving apparatus was located. At each end a short pole was erected and was connected to the transmitting and the receiving apparatus by means of insulated wires. He thus succeeded tn signalling across the garden but he could never have imagined that his success in this simple experiment would be the foundation of one of the most important aspects of our scientific civilization. He made constant improvements on the aparatus he used and thus continually increased the range of his transmissions until in the beginning of 1896 he was able to signal across a distance of 2 miles. In June 1896 he went to England and received introduction to Sir William Preece, Chief Engineer of the Post Office Telegraphs, who recognized Marconi's system in his official capacity and greatly assisted him in its development.

The essential features of the apparatus used by Marconi were all inventions of other scientists. The credit of Marconi lies in improving the details of these apparatus and also in making very valuable additions. He modified the "three-spark exciter" of Righi to increase efficiency of the transmitter. The coherer of Branly and Lodge was greatly sensitized in his hands. Repeated experiments soon led him to discover that the range of transmission can be greatly increased if, after the idea of Popoff, both the transmitter and the receiver are connected to

long vertical wires instead of to the short poles which were originally used. With these modifications he constantly added to the distance over which signals could be sent. At last in March 1899, to the intense excitement of the public, he was able to send signals from South Foreland to Wimereux, a village on the French coast at a distance of 32 miles from the transmitting station, thus bridging the English Channel.

By this time Sir Oliver Lodge discovered the principle of tuning or syntonization, as he called it, and showed that some degree of privacy in the messages transmitted could be obtained by this device. Marconi quickly took up the idea and embodied Lodge's principle in his subsequent improved type of transmitters and receivers It ought to be mentioned here that prior to this improvement, Marconi's system had the great disadvantage that secrecy of the messages could not be maintained and that with the installation of every additional transmitter mutual interference increased causing great difficulty in working. This was a serious drawback of any system of wireless communication and threatened to place drastic limitation on its application for confidential purposes.

It was now time for Marconi to increase the efficiency of the detector—the coherer of Branly had already been enormously improved by him. He found that the sensitivity of the coherer was not high enough to enable further increase of the range of successful transmission. He therefore discarded it and devised a new magnetic detector which had decided advantages over the coherer and was much more sensitive. With this improved apparatus Marconi succeeded in sending signals from St. Catherine's in the Isle of Wight to the Lizard in Cornwall, a distance of 155 miles. These repeated successes emboldened Marconi more than ever and early in 1901 he had already in his mind the apparently impossible task of bridging the Atlantic. He soon realized that this attempt would require for its success electric waves of far greater strength than had even before been produced. He replaced the batteries by a high power alternator and employed huge Leyden jars in place of the comparatively smaller ones hitherto used. A long-distance transmitting station was installed for the first time at Poldhu in Cornwall with high steel masts for erecting the aerials and with the newly designed high power spark generator.

In December 1901, Marconi arrived in Newfoundland with two assistants. They failed for the first few days in their anxious attempts to get aloft several huge kites for supporting the aerial. At length, on the 12th at about noon they managed with difficulty to fly a kite 400 ft up. A wire attached to the kite served for the aerial but Marconi failed to receive anything for about half an hour. It appeared for the time being that this daring attempt would ultimately end in failure. But Marconi was far too advanced to give up his task so easily. He and his assistant, Kemp, kept, on listening to the earphones with full attention. At last when the clock struck 12.30 p.m., with unprecedented excitement and joy, they heard the faint Morse dots signifying the letter "S" sent by the operators at Poldhu as previously arranged. Thus what had seemed to be an illusion a few minutes before now became an accomplished fact.

The success of Marconi in bridging the Atlantic opened a new era in the history of human civilization. It was the crowning achievement of Marconi and was undoubtedly the most memorable incident of his eventful career. It gave him a fresh impetus and with renewed energy he set to work on further developments of his apparatus in every detail. This resulted in increased reliability of wireless communication and as early as 1910 innumerable transmitting and receiving gears were installed in Europe and America including some exclusively meant for regular press service.

The next great achievement of Marconi was his success in inventing a new system of beam transmission. Since 1914 he was engaged in investigating the possibilities of short electric waves. He had already discovered that employing very small power regular communication could be made over much greater distances, specially at night, with short waves (129 metres or so) than with the longer waves (1000—20,000 metres) hitherto

used. With the aid of short waves he set up a system of beam transmission by which the radiation from the transmitter can be directed in a particular direction instead of being scattered uselessly in all directions. This system effected very great economy of power and cost and also had several other advantages over non-directional transmission.

With the development of beam transmission and with the experience gained regarding the advantages of short waves a large number of beam stations were established throughout the world. By 1929, a vast network of stations connecting important centres of the world was complete and communication by wireless became an indispensable necessity of everyday life.

During the next few years Marconi directed his attention to the application of micro-waves varying from 5 centimetres to 1 metre in length. He showed that these waves could be reflected almost as easily as ordinary light waves and could be utilized for speech transmission over moderate distances at the expense of remarkably small power. In fact he was able to speak to a distance of 170 miles with the aid of these waves with a power not greater than that consumed by the headlights of a motor-car.

In 1931 he invented what is called a radio "beacon" which facilitated the navigation of steam ships on the sea and the landing of aeroplanes during inclement weather. The blind landing of airships, a system which is still in its infancy, has been made possible by this valuable invention of Marconi.

The services rendered by Marconi by his invaluable researches in the domain of applied science received wide recognition all over the world. He was made a Chevalier of the Civil Order of Savoy in 1905 and in 1915 was elected a member of the Italian Senate. The Nobel Prize for Physics was awarded to him in 1909. He was created a Marchese in 1929 and in 1932 he received the Kelvin Medal.

During the closing years of his life his mind was busy with the novel idea of transmitting power by means of wireless. Report was published in the press a few months ago of his success in this direction, although only on an experimental scale.

He was conscious even in his old age of the limitless possibilities of wireless. The tremendous progress made durin the short period of a single man's career—that of the inventor Marconi—has been truly amazing and has no precedence in the whole history of physics. Yet he was not the man to give it up but had still further developments in his mind. "I find quite impossible", said Marconi, "to visualize any definite limit as to what more may be achieved in even the not far distant future... We are yet, in my opinion, a very long way from being able to utilize electric waves to anything like their full extent."

SCIENCE AND CULTURE

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Indian National Reconstruction and the Soviet Example

Scientific Research and Social Planning

When we started Science and Culture more than two years ago we wrote that our object was not only popularization of scientific knowledge but also to advocate the application of science to all problems of our national reconstruction. Our readers are already aware what we have done in this direction in the past. The Indian National Congress has now assumed office in seven important provinces and it is rumoured that they are contemplating schemes for national development. The All-India Congress Committee meeting held at Wardha in the middle of August passed resolutions embodying many of the views which we have been advocating from time to time in these columns. The Congress Working Committee has passed the following resolution :

> The Working Committee recommends to Congress Ministries the appointment of committees of experts to consider urgent vital problems, the solution of which is necessary for any scheme of national reconstruction and social planning. Such solution will require extensive surveys, collection of data as well as a clearly defined social objective. Many of these problems cannot be dealt with effectively on a provincial basis and the interests of adjoining provinces are interlinked.
>
> Comprehensive river surveys are necessary for the formulation of a policy to prevent disastrous floods and utilize water for purposes of irrigation, to consider the problem of soil erosion, to eradicate malaria and for the development of hydro electric and other schemes. For this purpose the whole river valley will have to be surveyed and investigated and a large scale of State planning resorted to. The development and control of industries require also joint co-ordinated action on the part of several provinces.
>
> The Working Committee advises, therefore, that to begin with an interprovincial committee of experts be appointed to consider the general nature of the problems to be faced and to suggest how and in what order this should be tackled. This expert committee may suggest the formation of a special committee or boards to consider each of such problems separately and to advise the provincial Governments concerned as to joint action to be undertaken.

We have reasons to believe that these resolutions of the most important political party of our country were inspired by articles appearing in our journal.

Many people in our country seem to imagine that the schemes we have advocated are too ambitious and expensive, but a parallel example from another country, which we are going to discuss, will show that if there is the will to work great progress can be achieved within a comparatively short period of time.

INDIAN NATIONAL RECONSTRUCTION AND SOVIET EXAMPLE

India similar to Pre-War Russia

Just before the War the conditions in Russia were in may respects similar to those in India. It was a country of huge resources in power, river water, and minerals and agricultural products, but all these were undeveloped. So that, in spite of potential plenty, the peasants who formed 91% of the population used periodically to die in millions of hunger and pestilence. The industries of the country were mostly in the hands of foreign capitalists and technicians. No scheme of national reconstruction could be pushed to a successful end due to conflicts with the vested interests created by the capitalist system. If the Bolsheviks who came to power after the revolution contented themselves with merely holding the political power as the Polish Government did they would have gone to the wall by this time. But as soon as they got power they initiated comprehensive plans for all-round national development in agriculture, industry, transport, organization of water resources, and enlisted the co-operation and service of the land for this purpose. They recognized that all these plans required patient and laborious study extending over years and convinced themselves that the work could be done successfully only if the country could train up her own children for the purpose and the State pushed on with the plans with all the power and resources at its disposal. The magnificent results of these plannings are now before the world.

Electrical Developments in U.S.S.R.

Let us consider the electrical developments of Soviet Russia. Before the Great War the country was so backward industrially that the production of electricity was only one-fourth that of Germany, a country with hardly half her population. Of the capital invested in electrical industries, 56% was German, 6% Swedish, 4% English, 4% others, and Russian capital was only 30% of the total; the positions in metallurgical industries, railways, coal, and oil were similar, if not worse.

Even in 1922, the production of electricity in Russia was less than that of tiny Switzerland, and the total length of railroads hardly exceeded that of France. Yet Russia was extremely rich in resources; in fact, extensive survey work, since undertaken by the Soviet Government, has revealed that her position in this respect is scarcely inferior to that of U. S. A. In coal reserves, she is second, in oil second, in peat reserves first, in water power first. In mineral resources, iron, aluminium, and precious metals, she easily occupies either the first or the second position. In agriculture, though her area was vast and the land fertile, a large part could not be cultivated on account of lack of irrigation facilities.

Yet these magnificent reserves were lying unutilized, whilst the rulers of pre-War Russia indulged in futile imperialistic schemes, thousands of miles away from their native land. There might be a plethora of grain in Ukraine, but in North Russia, peasants would be dying of hunger, as there were not sufficient railroads; where railrords existed, there would be no wagons. The waterways were useless on account of shallowness.

What happened during the Bolshevist regime is thus described in its official documents [*Electric Power Development in the U. S. S. R. -A collective study*, Laweace and Wishart, London, 1937]:

During these years, when as a result of the world war and the civil war, the country's backward productive force suffered unprecedented ruin and decline, Lenin put the historic programme for the restoration and forward reconstruction of Russia's national economy on new, socialist foundations, on the basis of the most advanced technique-electrification.

Long before the revolution, Lenin had theoretically worked out the concept of electrification in his scientific works as the technique that is adequate to socialist economy. Immediately after the October Revolution, in 1918 when the country was ablaze in the fires of civil war, Lenin requested the Academy of Sciences to begin the scientific and technical study of reorganizing industry and effecting the economic recovery of Russia. He emphasized the necessity of "Paying especial attention to the electri-

fication of industry and transport and to the employment of electrificity in agriculture."

In 1919-20, in a letter to G. M. Krzhizhanovsky, one of the most prominent theoreticians and advocates of planned electrification, Lenin outlined the fundamental principles underlying the great programme for the electrification of Russia, as the basis for building a planned economy for the country.

In Fabruary 1920 the Commission for Elaborating the Plan for the Governmental Electrification of Russia (Goelro) was founded on Lenin's initiative. This commission comprising some 200 of the most eminent scientists and engineers of the country, was headed by G. M. Krzhizhanovsky and this fundamental work, the Goelro plan, was completed by December 1920. It was submitted to the Eighth All Russian Congress of Soviets on Decemb r 22, 1920, and was approved by the latter.

This historic document, which underlies the economic construction of the country, is not only a project for the restoration and new construction of electric stations and electric transmission lines on a scale that was magnificent for that period, but also represents a carefully worked out unified State plan for the restoration and reconstruction of all national economy on the basis of advanced technique electrification.

In 1920 Lenin wrote as follows regarding this plan —

"A report on the electrification of Russia has been included in the agenda of the Congress of Soviets, so that the single economic plan for the restoration of national economy that we have been discussing may be outlined from the technical standpoint. *Unless Russia is placed on a different technical level, higher than before, restoration of the national economy and communism are out of the question. Communism is the Soviet power plus the electrification of the whole country, for without electrification progress in industry is impossible.*"

In a letter to Lenin in March 1921 Stalin characterized the Goelro plan as

"a masterly outline of a really national economic plan. The only Marxist attempt in our time to place a truly real, the only possible production base under the Soviet superstructure of economically backward Russia".

The Goelro plan was projected for a term of ten to fifteen years. It included a project, organically bound up with the plan of electrification, for the restoration, and reconstruction on new foundations, of the basic branches of economy and industry in the major regions of the country. It provided that the total volume of industrial production rise to 180-200 per cent of the pre-war level. It provided for about 17,000 million roubles of capital investments in industry.

The Goelro plan, in its major outlines, has been considerably overfulfilled not within fifteen years but within a ten-year period, *i. e.*, in the minimum time scheduled by the plan.

In the First and Second Five-Year Plans for the development of national economy (1928—32) and (1933—37) the Goelro principles were further detailed and developed, allowance being made for the new stage of development and the new problems put forward by the building of socialist economy.

In agriculture too, the Russians have done wonders. They have grown new plants and discovered new methods of agriculture by which it has been possible to grow wheat in the frost-bound regions of the Arctic, and millions of acres of lands have thus been rendered fit for human habitation. The Russian production in gold, iron, aluminium and other important minerals has exceeded that of U.S.A. The rivers of Russia have been developed to such an extent that today Moscow is an inland port connected with five seas, *i.e.*, the Baltic, the White, the Caspian, the Azov and the Black. Elsewhere in this issue we publish an article on the recently opened Moscow-Volga Canal from *La Nature*, which gives an idea of this magnificent engineering work.

The enormous development of Russia should give food for thought to all our politicians. In this connection, the contrast between the two neighbouring countries, Poland and Russia, both of whom started new political career after the War, is significant. Though Poland has made some progress, it is nothing compared to that of Russia. For instance, the production of electricity in Poland during the last eight years has remained practically stationary. This difference lies in the fact that Russia has been inspired by a new philosophy of life, a will to conquer nature, and has been able to evolve practical plans to put the ideas into practice.

Developments of Water Resources in U.S.S.R.

Recently we had the occasion to read a speech by an Hon. Minister on the development and utili-

zation of waterways of Bengal. If our Hon. Minister had a little more knowledge of the Russian programme much of his enthusiasm would have been damped. The Bengal Waterways Bill was passed some years ago and a development scheme was subsequently passed. An examination of these schemes shows that only pious hopes are expressed and neither the Government nor the officials have any idea as to what to do and how to do it. When Russia embarked upon her schemes of waterways development they put the whole thing before a meeting of the members of the Russian Academy of Science who could take a scientific and detached view on such problems. The Academicians took 3 to 4 years to study the schemes and recommended that first of all, a thorough survey of all rivers should be made with a view to ascertain their total water-carrying capacity, the possibility of distributing water by canals and hydro-electric development. So the Soviet Government opened no less than 2000 hydrological survey stations, organized a large number of geological survey parties, and surveyed the whole country from the economic point of view. While surveys were going on, training institutions were opened for giving the necessary instructions to the younger generation of students with a view to prepare them for shouldering the construction work. Commissions of advanced students under the able guidance of experienced professors were sent to foreign countries to study up-to-date methods. This required another 4 or 5 years of study and it was only in 1928, under the auspices of the so-called five-year plan, that the works of reconstruction were actually undertaken.

The success of Russia in developing power, industry and agriculture is entirely due to thoughtful planning extending over years. May we ask the spokesmen of the Governments all over India whether they have consulted any scientific man about their programmes, whether they have called into existence any organization for the necessary research and survey work, whether they have taken the trouble of raising in the country itself an army of young workers who are qualified to undertake the reconstruction work? The Governments had hitherto depended entirely on officials, but officials are not magicians and we know how Governments have managed things in the past. SCIENCE AND CULTURE will be publishing in near future how such progress has been achieved in Russia, and we hope that the new Governments will profit by these articles. We can say without fear of contradiction that if the Governments do not seriously undertake the reconstruction work, but confine their schemes to mere political programmes, and pick the pockets of a few rich men in order to give small relief to the peasants, they will be found wanting. How much work remains to be done in India will be clear from the fact that only about 2% of our hydro-electric resources have been developed. If all the national development schemes which have appeared in SCIENCE AND CULTURE can be carried out, and it depends upon those who hold the power, then the problems of proverty, flood, famine, and pestilence which have become chronic in our unfortunate country are bound to find a permanent solution.

Sea-Fisheries in Indian Waters

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WHAT are the future prospects of marine fisheries in and around India? In order to answer this question it is necessary first to define the meaning of the term Fisheries, for there are several kinds of marine fisheries, each with its own objects and difficulties, and each requiring differential treatment. Roughly these fisheries can be divided into :

1. Fisheries for Fish.

   These again may be grouped into

   (*a*) Estuarine fisheries,
   (*b*) Inshore fisheries, and
   (*c*) Deep-sea fisheries.

2. So-called Shell Fisheries.

   Of these there are several kinds, namely,

   (*a*) Fisheries for Crustacea, such as
   Prawn fisheries,
   Crab and Lobster fisheries.

   (*b*) Fisheries for Mollusca, such as
   Squids,
   Mussels, Clams, etc.

   (*c*) Fisheries for some product of the Mollusc ; such as,
   Mother-of-pearl,
   True pearls,
   Chank shell,
   Trochus shell.

   (*d*) Fisheries for the Holothurian :
   Beche-de-Mer.

In dealing with the question of the "Fish" fisheries there are a number of points that require consideration. At the present time these fisheries are carried on by means of nets operated from the shore, such as Seine-nets, or from sailing-boats fitted with various kinds of nets or long lines. However efficient these fishing vessels may be, they must inevitably suffer in competition with steam or motor-vessels, owing to their absolute dependence on the wind and the state of the weather; at a rough estimate 'power fishing' from motor or steam vessels, which are independent of such conditions and are able to fish all the year round, even during the south-west monsoon, and by reason of their greater speed can cover much greater distances in less time, is some ten times as efficient as fishing by sailing craft. The experimental work carried out by the *Golden Crown*, *William Carrick*, *Violet*, *Nautilus* and *Lady Goschen* around the coasts of India and Ceylon has shown that in these waters trawlers can secure catches of fish that compare quite favourably with the catches made in European and North Atlantic waters, and it seems clear that the fish fauna of Indian seas is sufficiently rich to make further development not only possible but essential. Unless this is done by India, Indian waters outside the three-mile limit and even inside it, especially in the absence of an adequate patrol by protecting vessels, will inevitably become a fishing ground for other nations who have already developed a modern fishing fleet; indeed recent reports of the working of Japanese fishing vessels in the Bay of Bengal show that this invasion of Indian waters has already begun.

It is probable that the whole of the Indian coastline will not be equally productive, for the work of the above-mentioned research-vessels indicated that certain areas are richer than others and every Indian fisherman knows that at times of the year certain fish are more abundant than at other seasons. In all the great maritime nations of the world a store of knowledge has gradually been built up and accumulated regarding the location of the best fishing grounds and the seasons when certain fish will be present in abundance, and although some of this knowledge may be handed down from father

to son and be withheld from rivals, much of this necessary information is now available in the form of special fishery charts, reports, etc.; but no such knowledge is available in India, except perhaps for inshore waters. Although the continental shelf, which forms the natural habitat of the commercial fish, has a width that around India varies from some 45 to 100 miles, the Indian fisherman of today or in the past has rarely, if ever, attempted to exploit the region lying beyond some 10-15 miles off the coast; even the *William Carrick* working off the Bombay coast carried out only 9 trawls beyond the 40-fathom line and of these only 4 were beyond the 50-fathom line, so that the possibilities of the edge of the continental shelf, lying at a depth of 80-100 fathoms, remain as yet unexplored except for the scientific work carried out by the R. I. M. S. *Investigator*. This knowledge, which is essential for the successful development of Indian fisheries, can therefore only be attained, either by long and arduous experience—by the process of trial and error—or else by the institution of fully equipped biological stations, with properly equipped and staffed research vessels, the necessity for which has now been recognized by almost every other civilized country in the world, even in those instances where the industry has had hundreds of years of experience at its back.

In a report on the Bombay fisheries, published in 1910, it was stated that "the question of the preservation of sea-fisheries does not arise, as, owing to the amazing fecundity of the fish, the harvest of the sea is so bountiful and so constant that overfishing is impossible. No means of destruction which man can devise can effect any appreciable reduction in the supply." Unfortunately experience in European and other waters suggests that this is by no means the case; a continuous and intensive exploitation of any fishing ground seems to lead to a gradual reduction in the amount of the catches, and it has been found necessary to introduce regulations of various kinds, such as the size of mesh of the nets, in order to prevent unnecessary and wasteful destruction of immature fish. This raises the question, at what age are the marketable fishes taken from the sea for consumption? Here again we have in India no exact knowledge, and such can only be obtained by investigation carried out by a scientific research staff. Do the fish in Indian waters maintain a more or less regular rate of reproduction year after year? Or does the rate vary irregularly, as has been shown to be the case with the herring of European waters? The Madras Fishery Department has had ample experience of the irregularity with which the oil-sardine appears off the west coast and this may be due to a greater rate of reproduction in certain years than in others or it may be due to other causes, such as the abundance or otherwise of their food-supply, which in its turn will ultimately prove, in all probability, to be due to changes in the character of the sea-water, though not necessarily in the sea-water off the Madras coast. Again it has been shown that certain fish, such as the pomfret or the "Bombay-duck" (*Harpodon*) exhibit annual migrations up and down both the east and west coasts of India; to what can this be attributed? The initial cause of such phenomena may lie in a region entirely different from that in which the fish are found and this can only be discovered by research work, carried out by trained scientists, which, if it is to be effective, cannot be limited to the coast of any one province of India or even to Indian territorial waters. Judging from the experience of marine biologists in European waters, changes in the character of the sea-water, such as a reduction in the amount of phosphates in solution, which causes a corresponding reduction in the production of plant life, lead indirectly to a diminution in the number of young fish; an estimate of the quantity of this substance and consideration of other scientific data may before long enable the scientists to predict the probable movements of the fish shoals and the increase or decrease in the rate of reproduction and thus put them in a position to advise the fishermen as to the best fishing grounds.

It has been reported in the English Press that the Government of Bengal are proposing to introduce steam-trawling in the Bay of Bengal in order that Indian trawlers may compete with the Japanese

trawlers that are already working there; but no explanation is given as to how it is proposed to carry out this scheme. Even if the necessary trawlers and fishing-gear are available in India or are obtained from elsewhere, where can the requisite staff be obtained from? Any development of Indian fisheries by the employment of steam- or motor-trawlers or drifters must be a gradual one, if it is not to affect very seriously the present fisherman. It is more than probable that trawling or other similar methods of capture will take the same species of fish that are now being taken by the sailing craft in inshore waters, while the employment of long drift-nets, such as are used by the steam-drifters, will certainly do so, and this will result in a falling off of the catches made by the sailing craft. Again, owing to their independence of wind and weather the fish-supplies obtained by "power" craft can be maintained at a more or less steady level all the year round, even during the south-west monsoon, and such catches will secure a ready market in preference to those of the sailing craft, whose catches are always irregular and during the south-west monsoon cease almost entirely. An essential therefore of such development must be the gradual conversion of the "sailing" fleet into a "power" fleet, so that the present fishing population will be absorbed and will not be thrown out of work by competition.

The full utilization and exploitation of the fisheries of India can never be brought about solely by the introduction of "power" fishing. Three or four trawlers, working off each of our big ports, would only succeed in completely glutting the market, even in those towns where adequate cold-storage facilities are available so that all surplus fish, not immediately required for consumption, may be kept in good condition. It is essential that there should simultaneously be an equal development in marketing and in transport facilities. With the exception of a few large towns on the coast, none of the population of India living more than some 20 miles from the sea can at the present time obtain fresh sea-fish, and the result of this is that there is a prejudice against eating it; though this would undoubtedly be overcome before very long, so far as the majority were concerned, if a steady campaign of propaganda were efficiently carried out, and, provided that the cost were not prohibitive, a large damand for fresh sea-fish in inland towns and villages would arise. All this, however, will necessitate co-operation between the fishing-fleet, the port-authorities and the railway companies; there will have to be adequate docking facilities at rates that are not excessive for the fish at the docks, and the transfer up-country of the fish in cold-storage vans on definite trains, the time of arrival of which must be known so that the local purchasers can take immediate delivery. If properly carried out, such arrangements would to a large extent eliminate the "middle-men," who in this, as in so many other trades, absorb so much of the profits; the ideal condition would, of course, be their complete elimination by trawling companies organizing their own selling agencies.

There can be little doubt that a considerable degree of development is also possible in both the inshore and estuarine fisheries of India, though the former will be very seriously affected unless steps are taken by the Government to ensure that foreign trawlers or drifters do not exploit the fishing grounds inside the three-mile limit. By improved methods these fisheries should be able not only to supply fresh fish in adequate quantities for the local market, but by improved methods of fish-curing or other forms of treatment, such as the preparation of fish-manure, etc., be able to attain a greater degree of prosperity.

On the other hand the so-called "shell-fisheries" appear to have shown a steady deterioration for many years and practically every report that has been submitted calls attention to this falling off in the quantity of the stock and of the catches that are being made. Here there seems to be urgent need of scientific investigation and advice, for there is little doubt that in many instances, such as the clam fishery of Bombay, there has been an appreciable deterioration in the stocks, due to over-fishing and a complete absence of any attempt to increase these by cultivation. There appear to be great possibilities of development in the prawn fisheries

in certain regions; already there is a demand for these "shell-fish", either fresh or dried, and a further market could in all probability be found for prawns, if these were bottled or tinned, provided that the process was properly carried out; but here again scientific research would be necessary in order to prevent the fishing of these crustacea when 'in berry' by instituting a "close-season" during which no fishing would be permitted.

It thus seems clear that if Indian fisheries are to be properly developed along modern lines to such an extent as will enable Indian fishermen to compete successfully with foreign fishing vessels, a conversion from sailing to power craft must be gradually brought about, and port authorities, cold-storage companies, and railways must also assist; but above all it is essential that there should be created a central fishery research department, equipped with research vessels, biological stations and a fully trained scientific staff, to study the potentialities of the fishing grounds, the development and habits of the more important marketable fish and the general character of the sea-water, food supply, etc., on which these habits depend, so as to be able to supply to the fishermen, in as short a time as possible, the knowledge that is essential for a successful fishing industry and that in other parts of the world has been gradually amassed by collective experience over hundreds of years and many generations of fisher-folk.

Oil Films—Living Cells

An important approach to the problem of simulating conditions in living tissue, that the difficulties encountered by these microscopic particles in their struggle for existence may be better studied, was discussed by Dr Irving Langmuir, associate director of the research laboratory of General Electric, at the recent Mark Hopkins centenary at Williams College. In his talk, entitled "Two-Dimensional Gases, Liquids, and Solids," Dr Langmuir described experiments with liquid films which have properties like those of a cell wall, thus creating in the laboratory substances which throw light on the behavior of living tissue. The research involved, conducted by Dr Katharine B. Blodgett and C. N. Moore, is an off-shoot of a general investigation of the properties of oil films on water.

"We have recently been investigating," said Dr Langmuir, "the intermediate field between acid and alkaline water, using solutions that are either neutral or slightly acid or alkaline. We also have investigated the effects of small amounts of calcium, magnesium, sodium, and potassium salts in water. We find that, in solutions which closely approximate sea water in regard to acidity and alkalinity and have similar amounts of dissolved salts, particularly interesting phenomena are observed.'

These phenomena, he explained, indicate that certain types of oil films on water, where they make contact with each other, are, in many respects, very similar to a cell wall. In these experiments, Dr Langmuir pointed out, "we have the advantage, however, that we can make this artificial cell wall cover a square foot if desired; we can study in detail properties which it would be very difficult to measure in a living cell.

"By quantitative studies, we can derive fundamental laws that govern these changes in properties. We hope, by following up this work, we shall be able to eastablish some principles that will be of great use to the biologist in understanding the complicated dependence of living cells upon the composition of the surrounding medium."

—*Scientific American*, September 1937.

Scientific Information about Jute in "Textile Fibres" by Mathews

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Textile Fibres by Mathews is considered as the standard work on the subject. The fourth edition of the book (published by Wiley and Sons, New York, 1924) is the latest. Among commercial fibres jute occupies two chapters. Scientific investigation about jute was taken up for the first time by Cross and Bevan during the latter part of the last century. They were the pioneer workers on cellulose and matters associated with it in vegetable fibres. In fact, much of the information about jute in Mathews' book has been gathered from their research papers. As is natural in the primary stage of any investigation, many things were suggested which have not stood the test of time. After the lapse of more than a decade, systematic study of the jute fibre was taken up by us in the Dacca University Chemical Laboratory, and in the course of the last twelve years of study, we have found that many of the findings of these workers are not acceptable. During the latter part of their work, they themselves expressed their doubt about the correctness of some of the statements made earlier. As a result of the extensive research work done all over the world during the last decade, our knowledge of the fibre has undergone profound changes. It is therefore high time that we should revise our ideas about the jute fibre. In the following pages I have tried to point out why many of the statements in Mathews' book require modification very badly. It will also be observed that there are some contradictory and anomalous statements about many of the constituents of jute. The object of this article is to supply accurate and up-to-date scientific information about jute to the reader interested in it. It is also hoped that in the next edition of the book these will be carefully considered by the author.

Originally Cross and Bevan believed that in bast fibres like jute, cellulose and lignin were chemically combined, and hence the name 'ligno-cellulose'. They went one step further and said that cellulose was capable of forming compound celluloses with any and every constituent of the bast fibre -here is the origin of such terms as pecto-cellulose,' 'adipo-cellulose'. 'cuto-cellulose', etc. They appear to have abandoned this idea subsequently[1]. The existence of such compound celluloses is not recognized to-day as it is considered that this type of combination is incompatible with the molecular structure of cellulose as revealed by the X-ray analysis of the fibre. From tensile strength determination and microscopic study of the raw and delignified fibre, the author has shown that in jute cellulose and lignin occur side by side without any chemical union[2]. Researches of many other workers—chief among them are Freudenberg and Wislicenus --show that the absorption theory is correct. So, even if we retain to-day the name ligno-cellulose for jute, we do not mean a chemical combination between the two. A good deal of confusion prevails throughout the book about what the author exactly means by ligno-cellulose and lignin. Thus, on page 347, it is written: "...the bast and vascular fibres always contain more or less alteration products of cellulose, chief among them is ligno-cellulose or lignin". Again, "...in fact jute is almost entirely composed of this latter substance, ligno-cellulose or lignin". Even if we agree with the author in calling jute a bastose or ligno-cellulose (p. 766, "...bastose is, properly speaking, a compound of cellulose with lignin"),

1. *Researches on Cellulose* IV, 1922, pp 170, 152.
2. *J. Indian Chem. Soc.*, 1935, *12*, 23.

SCIENTIFIC INFORMATION ABOUT JUTE IN "TEXTILE FIBRES" BY MATHEWS

it is rather difficult to identify lignin with ligno-cellulose, as he has done above and in some other places. Moreover, it has not been shown as yet that lignin is an 'alteration product of cellulose'. As a matter of fact, the two are entirely different chemically; cellulose is aliphatic in nature, while lignin is aromatic. Recently identity of celluloses from different sources has been established—we have shown that the only difference between jute and cotton cellulose is in the degree of polymerization; the former is less highly polymerized than the latter, and has therefore a lower molecular weight. Jute cellulose is not therefore an alteration product.

We come across two contradictory statements, on p. 767 and p. 766, which run as follows: "It must be borne in mind that jute fibre is a ligno-cellulose, composed of cellulose units about 1/8 in. in length cemented together by lignin components" and "...bastose (meaning jute) properly speaking is a compound of cellulose with lignin". Obviously, 'cemented together' never conveys an idea of chemical combination, and so it is difficult to reconcile these two views. Again on p. 773, we find, "Jute contains a large amount of modified cellulose, known as ligno-cellulose. As this latter compound differs essentially both in its chemical composition and reactions from ordinary cellulose ..." If the author really means to say that jute is a compound of cellulose with lignin, he is hardly justified in callling it a modified cellulose', for in a compound of two, one is as important as the other. One might call it 'modified lignin' as well, which would scarcely be expressive. It is difficult to guess what the author wants to say in the following: "Chemically, the formation of lignin is to be regarded as a combination of cellulose with acid and unsaturated ketonic groups" which occurs in p. 771. It is not clearly mentioned with what acid or unsaturated ketones cellulose will combine to give us lignin. If we accept this view regarding the formation of lignin, it must be shown that cellulose or sugar molecules are constituent parts of lignin; or, in other words, one must obtain glucose from the decomposition products of lignin. This has not been found as yet. It is difficult to visualize a stable union between alcoholic hydroxyl groups in cellulose (for, these are the only groups free in cellulose) with unsaturated ketonic groups. Even if the result of this combination be lignin itself, what then is ligno-cellulose?

As a matter of fact, our ideas regarding the formation of lignin are still in the amorphous state. But even in our present position, we can say definitely that lignin is not allied to cellulose chemically. The so-called synthetic lignin of Hawley and Harries,[3] prepared from cellulose by heating, has been shown to be quite different from natural lignin.[4] The views of Hilpert and co-workers[5] that lignin is formed from cellulose material during the process of isolation have met with almost universal contradiction.

Then again, on p. 774, we find, "The cellulose in jute and similar fibres may be separated by treatment with chlorine ..." The expression is not quite clear. Here the author perhaps means lignin by ligno-cellulose, for, as we know, chlorine removes lignin as chloro-derivative in such a case. Here lignin and ligno-cellulose have been confused, though, according to Cross and Bevan, ligno-cellulose stands for bast fibres like jute, flax, etc. If ligno-cellulose has its usual significance in the above statement, it presupposes the existence of free cellulose (in contradistinction to ligno-cellulose) in jute, for which there is no definite proof. That ligno-cellulose is not lignin itself is quite evident from the statement made in p. 508, " Ligno-cellulose (represented among the fibres by jute) consists of 75% cellulose and 20% lignin". Here lignin is only a constituent of ligno-cellulose.

Regarding the percentage of lignin in jute, unfortunately, we find no two concordant data in the book. In our experiments with the jute fibre, we have always found it to be very approximately 15%, provided the fibre is mature and of the same variety. In p. 351, the percentage of lignin in jute, as determined by the methyl value, is given as 40.26%, which is certainly abnormally high. Then in p. 771

3. *Ind. Eng. Chem.* 1932, *24*, 873.
4. Sarkar, *J. Indian Chem. Soc.*, 1933, *10*, 265.
5. *Ber.*, 1934, *67*, 1551, and later issues.

we find, "In jute the amount of cellulose is about 70-80% and lignone about 30-20%". Then again, in p. 508, "Ligno-cellulose (represented among fibres by jute) consists of 75% cellulose and 25% lignin". Next to cellulose, lignin is the most important constituent of the jute fibre. It is desirable that the reader should have an accurate idea about its percentage, if not about its chemical nature.

In many places the percentage of cellulose and that of lignin (in the case of jute) make 100, conveying the idea that jute consists solely of cellulose and lignin, which is not a fact. We have found pectin, uronic acids, fatty and resinous matter and also some inorganic constituents in jute besides cellulose and lignin. The following represents very approximately the composition of the jute fibre as found in our laboratory :

α- cellulose	67.0%
Hemicelluloses	7.0 „
Lignin	15.1 „
Uronic acids	8.0 „
Pectin	2.0 „
Fat and resin	0.9 „
Ash	0.5 „

The hemicelluloses are more or less ill-defined bodies even to-day. In the case of jute, they have been found to consist of—among hexoses galactose, fructose and glucose (most probably as galactan, etc.), and—among the pentoses—arabinose and xylose. No other sugar was detected in the hemicelluloses from jute. Uronic acids consist of glycuronic and galacturonic acids only. In view of the above, the author of the book is not justified in saying, 'In jute, the amount of cellulose is about 70-80% and the lignone about 30 - 20%" in p. 774 ; and again in p. 508, "Ligno-cellulose (represented among the fibres by jute) consists of 75% cellulose and 25% lignin". From these and similar other statements the reader derives only a vague idea about the composition of the jute fibre.

In p. 774 we find, "The separation of cellulose is attended by disintegration and the fibre is resolved into its component cell units, which are usually 2-3 mm in length." Now, this is not always the case, *e.g.* when cellulose is separated from lignin by means of chlorine dioxide gas in presence of moisture, the fibre maintains not only its original length (which may be several feet) but also its original structure as seen under the microscope. The tensile strength (in the long condition) as well remains practically constant after delignification[6].

In p. 345, jute is stated to have 6.00% hygroscopic moisture. Now the moisture content of jute (and, as a matter of fact, of all vegetable fibres) depends upon the relative humidity of the atmosphere. Thus, in August at Dacca, raw jute is found to contain 15.75% moisture, in December, 12.04% and in March, only 8.4%, which is the lowest figure for the year. In an atmosphere with 65% R. H. jute is found to contain 13.75% moisture.[7] So the figure 6.00% carries no definite meaning unless the relative humidity is mentioned side by side.

Regarding the colour of the raw jute fibre, one gets no clear and definite idea. In p. 343 we find, "while still others, like jute and hemp, have a decided brown colour". But in p. 762 we find "The fibre (jute) possesses a yellowish brown colour, though the best qualities are yellowish white or silver grey". The normal colour of fresh jute is never brown. The best quality of jute is almost as white as raw cotton. The colour, however, turns pale brown if the jute (raw or delignified) is stored for a sufficiently long time. The worst quality of jute, like the worst type of cotton, is not, of course, white. About the cause of this colour, in p. 347, we find, "All vegetable fibres appear to contain more or less pigment matter usually of a slight yellowish or brownish colour. ... Jute contains considerable amount of pigment and is of a more or less pronounced brownish colour". We have sufficient reasons to believe that the colour of jute is due to the presence of lignin. When lignin is removed—say, by means of ClO_2, the fibre becomes milk-white. The colour of cotton fibre is however due to a very small amount of pigment. Besides lignin, no colour-

6. Sarkar, *J. Indian Chem. Soc., 12,* 1935,24.
7. Barker, *Jute Research in 1935-36*, p. 17.

ing matter or pigment has yet been shown to be present in jute. As is well known, cotton contains no lignin. One should not therefore call lignin a pigment.

In p. 343, one reads, "These colours (of jute and hemp) are however due to incrusting impurity as the cellulose fibres are always white". As the 'pigment' is 'considerable', the author certainly means lignin and no other colouring matter. Lignin is characterized as 'incrusting impurity' and as such it scarcely conveys the idea of a chemical combination by which one might get a ligno-cellulose. If, according to the author, the percentage of lignin in jute is as high as 40. 26% (p. 351) one should not perhaps call it an 'impurity'.

As regards furfural-yielding bodies, in p. 774, we read, "Normal cellulose does not yield furfural whereas ligno-cellulose does, thereby indicating the possibility of its containing an oxy-cellulose derivative". 'Oxy-cellulose derivatives' are not the only bodies that give furfural on acid distillation. As is well known, ligno-celluloses, as a rule, always contain pentoses or pentosans, which invariably yield furfural. Even some hexoses have been found to give small quantities of furfural, *e. g.*, 'galactan and some fermentable sugars of apple wood have been found to yield furfural on acid distillation'[8]. Hexoses give levulinic acid and formic acid on being heated with HCl, hydroxy-methyl furfural being an intermediate product. But Heuser actually got furfural as well[9]. Glucose or glucosans will, therefore, behave similarly. Thirdly, as pectin contains galacturonic acid and arabinose (Ehrlich), it must give sufficient amount of furfural on acid distillation. So there are many 'possibilities' of obtaining furfural from a ligno-cellulose, besides oxy-cellulose derivatives.

If the author means cotton by "normal cellulose," the first part of the statement is not quite correct, as cotton cellulose as well always gives a small quantity of furfural under similar conditons[10]. And if it stands for α-cellulose, in that case as well it is not precisely accurate, for we have found it impossible to free α-cellulose, obtained either from jute or from cotton, from furfural-yielding complexes; in our case, the former contained 0.25%, and the latter 0.29% of furfural.[11]

In p. 774, we have, "Lignin (jute lignin) reacts quantitatively with chlorine in a characteristic and invariable proportion". The writer's paper on the chlorination of jute lignin [12] will very clearly show that this is untenable; the proportion is not at all 'invariable'. A slight variation in the experimental conditions causes a wide difference in the chlorine content of the derivative obtained. But under similar conditions identical products are obtainable. We have been able to prepare three definite chloro-derivatives from jute lignin, with 17. 7%, 25. 8% and 32. 7% of Cl. Many other investigators have got more than one chloro-lignin by direct chlorination. The original observations of Cross and Bevan[13] in obtaining a lignone chloride ($C_{19}H_{18}O_9Cl_4$) have been proved to be erroneous. A second derivative of jute lignin was prepared by the same workers[14] by chlorination and it was found to agree with the formula $C_{38}H_{11}Cl_{11}O_{16}$. So it was already known that the proportion is not 'invariable.'

The tensile strength of jute fibre has been mentioned to be 28. 7 Kg per sq. mm in p. 446, while in p. 344 we find the value 49. 51 Kg per sq. mm. for the same. Naturally, the reader is in a fix as to which value to accept and which to reject. The tensile strength of jute fibre as determined by the writer is 14. 46 Kg sq. mm[15]. The strength remains unchanged practically even on storage for 2 years, if it is kept in a dry place.

8. p. 35, *Wood Cellulose*, by Hawley and Wise, A. C. S. Monograph.

9. *Text Book of Cellulose*, by Emil Heuser, p. 100.

10. *J. Indian Chem. Soc.*, 1932, *9*, 617.
11. *loc. cit.* p. 618.
12. *J. Indian Chem. Soc.*, 1934, *11*, 777-785
13. *J. C. S.*, 1893, *12*, 104
14. *J. C. S.*, 1883, *43*, 18
15. *J. Indian Chem. Soc.*, 1935, *12*, 23.

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As general characteristics of fibres, mention is made in p. 348 of the following: "Albuminous matter also occurs in the fibre elements, mostly as dried tissue which fills the lumen of the fibre more or less completely." But the jute fibre must be considered as an exception as it is absolutely free from any trace of nitrogen and so albuminous matter cannot occur in it.

Regarding the prepartion of the fibre, in p. 762 we find, "The plant is usually cut when in bloom and stalks are freed from leaves, seed capsules, etc". In actual practice, however, the plant is seldom cut when in bloom unless the cultivator wants to obtain seeds for the next season, for which he selects a high land usually with a small area, the growing of the seed being the main object, that of the fibre secondary. The stalks are scarcely freed from leaves an operation which is not only laborious but also unnecessary. The leaves rot earlier than the stalks and this helps, it is believed, the retting of jute.

In p. 767 we read, "The chief chemical difference between jute and pure cellulose is in the ability of the former to combine directly with basic dyestuffs. In fact, it acts in this respect similar to cotton which has been mordanted with tannic acid". If jute is only a ligno-cellulose, as the author holds, this behaviour of the fibre cannot be explained; for neither cellulose nor lignin has any affinity for basic dyestuffs. Our researches have shown that uronic acids present in jute are responsible for this.[16] Jute cellulose freed from these acids will behave exactly in the manner as other celluloses.

In p. 776, we find, "HI reacts with ligno-celluloses with the formation of CH_3I. The estimation of the latter volatile product is taken as the index of methoxy groups present in ligno-cellulose. This may also be considered as the 'chemical constant of lignification'. Jute has 1.87% methoxy". In view of the fact that jute contains pectin matter, which again has some methoxyl groups attached to it, HI liberates CH_3I from this as well and so the methoxyl value of jute cannot obviously be considered as the 'chemical constant of lignification' exclusively. Moreover, in a paper[17] by the writer it has been shown that raw jute contains 3.965% of methoxy and not 1.87% and also delignified jute has a methoxy value of 1.338%.

The methods of estimation of different constituents are not all free from objections. Thus in p. 769, under estimation of pectic acid, one reads, "After HCl treatment, 2% NaOH is used for the extraction of pectic acid, which is precipitated by HCl". Now, hemi-celluloses as well are soluble in dilute alkalies and precipitated by mineral acids, and hence they will vitiate the results for pectic acids. As a matter of fact, by the above procedure, it is stated in the same page, from 22 gms of jute were obtained 5.455 gms of pectic acid, *i. e.* 24.8%. The figure is certainly very high and, moreover, one cannot make any guess regarding the composition of jute in a quantitative manner. If it contains 70-80% cellulose and 20-30% lignin, how can it contain 24.8% pectic acid (the percentage of pectin will be higher still)? We have extracted the pectin from delignified jute by 0.5% ammonium oxalate[18] and found the percentage to be 2.18. Calculated on dry raw jute, it comes to 1.87% only—a figure quite consistent with the percentage of furfural and uronic CO_2 obtained from jute. In the previous page (768) the table gives Incrusting and pectin matter—21.9 to 25.36%. The author in some places mentions lignin as incrusting matter. And nowhere in the book we find a lignin content lower than 20%. It is really very difficult to reconcile this with the pectic acid content, *viz.*, 24.08%. Secondly, hemi-celluloses also are considered as incrusting matter and the writer has shown that they are the real binding material in jute. The above figures ought to include hemi-celluloses as well.

In p. 769, we come across the term 'pectose' which is estimated by boiling jute (freed from lime and pectates) with 2% boiling HCl. The pectose, it is stated, is thereby converted into pectin. The real significance of this is difficult to understand.

16. *Indian Chem. Soc.*, 1932, *9*, 291.

17. *J. Indian Chem. Soc.*, 1935, *12*, 17

18. *J. Indian Chem. Soc.*, 1932, *9*, 291

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The so-called compound of cellulose with pectin matter is pecto-cellulose (p. 352) and not pectose which remained undefined all through. This pectose is not also included in the constituents of jute. In p. 347 the author says, "In their chemical composition vegetable fibres consist of three parts:- cell tissue (cellulose), woody tissue (liginin) and cork tissue (cutose)". This cutose, according to the author, 'doubtless results from plant wax' and is therefore not related to pectose. By pecto-cellulose to-day we mean nothing practically, as no combination between pectin and cellulose is considered possible.

Several methods for the estimation of cellulose in ligno-celluloses are given, each giving a result different from others. Thus in p. 769 it is recorded that cellulose is estimated for 8 days by copper oxide ammonia and the value obtained is 50%, while just in the previous page (768) the percentage of cellulose is given as 61. 71-64. 24 and again in page 353 jute is stated to have 76% of cellulose. Which value is the reader to accept as *correct*? It has been shown from our laboratory[19] that chlorine in presence of moisture acts as an oxidizing agent on cellulose and, as a result, always lower values are obtained by this method. Chlorine peroxide has been found to be an excellent reagent for the estimation of cellulose; the lignin alone is dissolved away without affecting any other constituents. The maximum value for raw cellulose from jute has been 76.1% by Cross and Bevan's method and 57.82% for α-cellulose obtained therefrom; while, by the ClO_2 method, we obtained 81.8% raw cellulose and 60.67% α-cellulose, both being free from lignin. Raw cellulose here includes hemi-celluloses, uronic acids and pectin. We have compared this α-cellulose from jute with that from cotton and found them to be identical except in respect of molecular weight which is far lower than that of cotton. In p. 769 methods for the estimation of para-cellulose, cutose, vasculose, metacellulose, etc., are described. These are all ill-defined bodies—no cellulose chemist of the present time recognizes them. Vasculose, according to the author (p. 509), is 'identical with ligno-cellulose', while, in some other places, lignin is said to be the same as ligno-cellulose (p. 347), creating a good deal of confusion.

In p. 775 he says, "Bromine cannot be used in place of chlorine as it acts on the cellulose to some extent giving a figure for ligno-cellulose from 2-5% higher". Here again the author used the term ligno-cellulose for lignin. As we have already shown chlorine as well 'acts on cellulose to some extent' and has therefore practically no great advantage over bromine.

In p. 347, we find, "Woody tissue is soluble in conc. H_2SO_4 with a strong brown colouration but insoluble in copper oxide ammonia solution." If the woody tissue means lignin, as the author holds, it cannot be soluble in conc. H_2SO_4. As is well known, 72% H_2SO_4 is used for the separation and estimation of lignin in ligno-celluloses. If he means ligno cellulose, it is partly soluble both in H_2SO_4 and copper oxide ammonia, as the cellulose part will dissolve therein, but not the lignin.

In p. 350 under 'estimation of lignin in fibres' we find a method based on the determination of methyl value, "that for pure lignin being taken as 52.9". It is the methoxyl value that is actually determined by Zeisel's method and so the results would have been better expressed by methoxyl value. This so-called methyl value of pure lignin cannot be understood as the methyl value (CH_3) when converted into methoxyl value (CH_3O) will more than double itself. The methoxyl value for lignin then comes to about 105. 8%, certainly an absurd figure. The highest value we have obtained for jute lignin is 18. 37%.[20] Even if the method were otherwise correct, it could not be used directly for the estimation of lignin for the simple reason that jute contains pectin, which again has a methoxyl value of 12. 2%.[21] The above method gives 10. 26% as the lignin content of jute fibre, which, as we have already pointed out, is untenable.

19. *J. Indian Chem. Soc.*, 1929, *6*, 239

20. *J. Indian Chem. Soc.*, 1935, *12*, 171.

21. *J. Indian Chem. Soc.*, 1930, *7*, 356.

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In p. 768, the statement "...ligno-cellulose molecule contains formyl and acetyl groups" cannot be accepted, as recent investigations have proved otherwise[22].

In p. 775, for the estimation of furfural, phenylhydrazine method is recommended, but we have always found, along with other workers, the phloroglucinol method to give better results. In p. 767 it is stated, "A solution of ferric ferricyanide colours ligno-cellulose a deep blue owing to the de-oxidation of the ferric compound by the lignone. This reaction is useful in following the progressive elimination of the lignone constituents in the isolation of pure cellulose from jute". Genuine lignin from jute has been found to possess no reducing property at all[23]. Secondly, separation of 'pure cellulose' by ferric ferricyanide has not been shown to be a method followed in the laboratory.

Lastly, regarding the origin of the name 'jute', the author says in p. 760, "The name jute is derived from the Sanskrit 'jhot', meaning to be entangled." But the popular belief in this country is that 'pat' stood at one time for silk. The English people called fibre from *corchorus capsularis* 'jhut pat' meaning "false silk". Subsequently, for brevity, perhaps, the word 'pat' was dropped and it began to be known as 'jhut' and then as jute, which is more easily pronounced.

22. Sarkar, *J. Indian Chem. Soc.*, 1935, *12*, 168

23. Sarkar, *J. Indian Chem. Soc.*, 1934, *11*, 691,

New Lamps for Deep Sea Work

When Captain John D. Craig descends this summer to the wreck of Lusitania to film the scheduled salvage operations, his equipment will include a battery of the most powerful lamps ever designed for deep sea work. The new lamps, developed by engineers of the General Electric Co., are built to withstand a water pressure of 500 lb. per sq. in., more than three times the pressure encountered around the hull of the vessel, submerged in 312 feet of water off the Irish Coast, where the pressure is 150 lb. per sq. in. Each lamp has a light output of 137,500 lumens. A set of twelve of these will be mounted on a special submarine stage, to floodlight the scene. The intense heat at which the lamps operate would cause them to fail in a few minutes if burned in the open air. Due to the cooling action of the water, however, they will function for 25 hrs. The bulbs, made of special, hard ultra-violet transmitting glass to provide the best possible photographic light, are filled with a mixture of nitrogen and argon, and fitted with special rubber insulation to insure perfect waterproofing.

Jour. Frank. Inst., Aug. 1937.

The Informative Content of Education

H. G. Wells

SECTION L of the British Association is of necessity one of the least specialized of all sections. Its interests spread far beyond professional limitations. It is a section where anyone who is so to speak a *citizen at large* may hope to play a part that is not altogether an impertinent intrusion. And it is in the character of a citizen at large that I have accepted the very great honour that you have offered me in making me the President of this section. I have no other claim whatever upon your attention. Since the remote days when as a needy adventurer I taught as non-resident master in a private school, invigilated at London University examinations, raided the diploma examinations of the College of Preceptors for the money prizes offered, and in the most commercial spirit, crammed candidates for the science examinations of the university, I have spent very few hours indeed in educational institutions. Most of those were spent in the capacity of an enquiring and keenly interested parent at Oundle School. I doubt if there is any member of this section who has not had five times as much teaching experience as I have, and who is not competent to instruct me upon all questions of method and educational organization and machinery. So I will run no risks by embarking upon questions of that sort. But on the other hand, if I know very little of educational methods and machinery I have had a certain amount of special experience in what those methods produce and what that machine turns out. I have been keenly interested for a number of years, and particularly since the war, in public thought and public reactions, in what people know and think and what they are ready to believe. What they know and think and what they are ready to believe impresses me as remarkably poor stuff. A general ignorance—even in respectable quarters—of some of the most elementary realities of the political and social life of the world is, I believe, mainly accountable for much of the discomfort and menace of our times. The uninstructed public intelligence of our community is feeble and convulsive. It is still a herd intelligence. It tyrannizes here and yields to tyranny there. What is called elementary education throughout the world does not in fact educate, because it does not properly inform. I realized this very acutely during the latter stages of the war and it has been plain in my mind ever since. It led to my taking an active part in the production of various outlines and summaries of contemporary knowledge. Necessarily they had the defects and limitations of a private adventure but in making them I learnt a great deal about—what shall I say?—the contents of the minds our schools are turning out as taught.

And so now I am proposing to concentrate the attention of this section for this meeting on the question of what is *taught as fact*, that is to say, upon the *informative side of educational work*. For this year I suggest we give the question of drill, skills, art, music, the teaching of languages, mathematics and other symbols, physical training and development, a rest, and that we concentrate on the inquiry: *What are we telling young people directly about the world in which they are to live?* What is the world picture we are presenting to their minds? What is the framework on conceptions about reality and about obligation into which the rest of their mental existences will have to be fitted? I am proposing in fact a review of the *informative side of education*, wholly and solely—informative in relation to the needs of modern life.

And here the fact that I am an educational outsider—which in every other relation would be a disqualification—gives me certain very real advan-

tages. I can talk with exceptional frankness. And I am inclined to think that in this matter of the informative side of education frankness has not always been conspicuous. For what I say I am responsible only to the hearer and my own self-respect. I occupy no position from which I can be dismissed as unsound in my ideas. I follow no career that can be affected by anything I say. I follow, indeed, no career. I have no party, no colleagues or associates who can be embarrassed by any unorthodox suggestions I make. Every schoolmaster, every teacher, nearly every professor must, by the nature of his calling, be wary, diplomatic, compromising he has his governors to consider, his college to consider, his parents to consider, the local press to consider; he must not say too much nor say anything that might be misinterpreted and misunderstood. I can. And so I think I can best serve the purposes of the British Association and this section by taking every advantage of my irresponsibility, being as unorthodox and provocative as I can be, and so possibly saying a thing or two which you are not free to say but which some of you at any rate will be more or less willing to have said.

Now when I set myself to review the field of inquiry I have thus defined, I found it was necessary to take a number of very practical preliminary issues into account. As educators we are going to ask what is the subject-matter of general education? What do we want known? And how do we want it known? What is the essential framework of knowledge that should be established in the normal citizen of our modern community? What is the irreducible minimum of knowledge for a responsible human being to-day?

I say irreducible minimum—and I do so, because I know at least enough of school work to know the grim significance of the school time-table and of the leaving school age. Under contemporary conditions our only prospect of securing a mental accord throughout the community is by laying a common foundation of knowledge and ideas in the school years. No one believes to-day, as our grandparents —perhaps for most of you it would be better to say great-grandparents—believed, that education had an end somewhen about adolescence. Young people then left school or college under the imputation that no one could teach them any more. There has been a quiet but complete revolution in people's ideas in this respect and now it is recognized almost universally that people in a modern community must be learners to the end of their days. We shall be giving a considerable amount of attention to continuation adult and postgraduate studies in this section, this year. It would be wasting our opportunities not to do so. Here in Nottingham University College we have under Professor Peers the only Professorship of Adult Education in England, and the Adult Education Department which is in close touch with the Workers' Education Association has broadened its scope far beyond the normal range of Adult Education. Our modern idea seems to be a continuation of learning not only for university graduates and practitioners in the so-called intellectual professions, but for the miner, the plough-boy, the taxi-cab driver and the out-of-work, throughout life. Our ultimate aim is an entirely educated population.

Nevertheless it is true that what I may call the main beams and girders of the mental framework must be laid down, soundly or unsoundly, before the close of adolescence. We live under conditions where it seems we are still only able to afford for the majority of our young people, freedom from economic exploitation, teachers even of the cheapest sort and some educational equipment, up to the age of 14 or 15, and we have to fit our projects to that. And even if we were free to carry on with unlimited time and unrestrained teaching resources, *it would still be in those opening years that the framework of the mind would have to be made.* We have got to see therefore that whatever we propose as this irreducible minimum of knowledge must be imparted *between infancy and- at most, the fifteenth or sixteenth year.* Roughly, we have to get it into ten years at the outside.

And next let us turn to another relentlessly inelastic packing-case, and that is the school time-table. How many hours in the week have we got for this job in hand? The maximum school hours we have available are something round about thirty,

but out of this we have to take time for what I may call the non-informative teaching, the native and foreign language teaching, teaching to read, teaching to write clearly, basic mathematical work, drawing, various forms of manual training, music, and so forth. A certain amount of information may be mixed in with these subjects but not very much. They are not what I mean by informative subjects. By the time we are through with these non-informative subjects, I doubt if at the most generous estimate we can apportion more than six hours a week to essentially informative work. Then let us, still erring on the side of generosity, assume that there are 40 weeks of schooling in the year. That gives us a maximum of 240 hours in the year. And if we take ten years of schooling as an average human being's preparation for life and if we disregard the ravages made upon our school time by measles, chicken-pox, whooping-cough, coronations and occasions of public rejoicing, we are given 2,400 hours as all that we can hope for as our time allowance for building up a coherent picture of the world, the essential foundation of knowledge and ideas, in the minds of our people. The complete framework of knowledge has to be established in two hundred dozen hours. It is plain that a considerable austerity is indicated for us. We have no time to waste, if our schools are not to go on delivering, year by year, fresh hordes of ignorant, unbalanced, uncritical minds, at once suspicious and credulous, weakly gregarious, easily baffled and easily misled, into the monstrous responsibilities and dangers of this present world. Mere cannon-fodder and stuff for massacres and stampedes.

Our question becomes therefore: 'What should people know—whatever else they don't know? Whatever else we may leave over—for leisure-time reading, for being picked up or studied afterwards—what is the irreducible minimum that we ought to teach as clearly, strongly and conclusively as we know how?'

And now I—and you will remember my rôle is that of the irresponsible outsider, the citizen at large—I am going to set before you one scheme of instruction for your consideration. For it I demand *all* those precious 2,400 hours. You will perceive the scheme is explicitly exclusive of several contradictory and discursive subjects that now find a place in most curricula, and you will also find doubts arising in your mind about the supply and competence of teachers, a difficulty about which I hope to say something before my time is up. But teachers are for the world and not the world for teachers. If the teachers we have to-day are not equal to the task required of them, then we have to *recondition* our *teachers or replace them.* We live in an exacting world and a certain minimum of performance is required of us all. If children are not to be given at least this minimum of information about the world into which they have come through no fault of their own then I do think it would be better for them and the world if they were not born at all. And to make what I have to say as clear as possible I have had a diagram designed which I will unfold to you as my explanation unfolds.

You have already noted I have exposed the opening stage of my diagram. You see I make a three-fold division of the child's impressions and the matters upon which its questions are most lively and natural. I say nothing about the child learning to count, scribble, handle things, talk and learn the alphabet and so forth because all these things are ruled out by my restriction of my address to information only. This is what it wants to know. In all these educational matters, there is an element of overlap. As it learns about things and their relationship and interaction its vocabulary increases and its ideas of expression develop. You will make an allowance for that.

And now I bring down my diagram to expose the first stage of positive and deliberate teaching. We begin telling true stories of the past and of other lands. We open out the child's mind to a realization that the sort of life it is living is not the only life that has been lived and that human life in the past has been different from what it is to-day and on the whole that it has been progressive. We shall have to teach a little about law and robbers, kings and conquests, but I see no need at this stage to afflict the growing mind with dates and dynastic

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Early Civilizations.
General Significance of Persia, Greece, Carthage, Rome, China Islam, Christendom, & America in History.
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DESCRIPTIVE BOTANY.
ELEMENTARY PHYSIOLOGY OF PLANTS & ANIMALS.
HEALTH.

STATES OF MATTER.
Composition of Matter
Elementary Physiography

ELEMENTARY MATTER.
Elementary Ideas About Human Cultures and their Development in time,
Savage Life, Tools, and Weapons. Primitive Homes Caves, Shelters, Huts, Clothing
Agriculture and the Domestication of Animals,
Trade . Towns . Ships
Predatory Peoples and Warfare.
[No Dates Yet - No Dynasties]

particulars. I hope the time is not far distant when children even of eight or nine will be freed from the persuasion that history is a magic recital beginning 'William the Conqueror, 1066.' Concurrently, we ought to make the weather and the mud pie our introduction to what Huxley christened long ago as Elementary Physiography. We ought to build up simple and clear ideas from natural experience.

We start a study of the states of matter with the boiling, evaporation, freezing and so on of water and go on to elementary physics and chemistry. Local topography can form the basis of geography. We shall have to let our learner into the secret that the world is a globe—and for a time I think that has to be a bit of dogmatic teaching. It is not so easy as many people suppose to prove that the world is spherical and that proof may very well be left to make an exercise in logic later on in the education. Then comes biology. Education I rejoice to see is rapidly becoming more natural, more biological. Most young children are ready to learn a great deal more than most teachers can give them about animals. I think we might easily turn the bear, the wolf, the tiger and the ape from holy terrors and nightmare material into sympathetic creatures, if we brought some realization of how these creatures live, what their real excitements are, how they are sometimes timid, into teaching. I don't think that descriptive botany is very suitable for young children. Flowers and leaves and berries are bright and attractive, a factor in æsthetic education, but I doubt if, in itself, vegetation can hold the attention of the young. But directly we begin to deal with plants as hiding-places, homes and food for birds and beasts, the little boy or girl lights up and learns. And with this natural elementary zoology and botany we should begin elementary physiology. How plants and animals live, and what health means for them.

There I think you have stuff enough for all the three or four hundred hours we can afford for the foundation stage of knowledge. Outside this substantial teaching of school hours the child will be reading and indulging in imaginative play—and making that clear distinction children do learn to make between truth and fantasy—about fairyland, magic carpets and seven league boots, and all the rest of it. So far as my convictions go I think that the less young children have either in or out of school of what has hitherto figured as *history*, the better. I do not see either the charm or the educational benefit of making an important subject of the criminal history of royalty, the murder of the Princes in the Tower, the wives of Henry the Eighth, the families of Edward and James I, the mistresses of Charles II, Sweet Nell of Old Drury, and all the rest of it. I suggest that the sooner we get all that unpleasant stuff out of schools, and the sooner that we forget the border bickerings of England, France, Scotland, Ireland and Wales, Bannockburn, Flodden, Crecy and Agincourt, the nearer our world will be to a sane outlook upon life. In this survey of what a common citizen should know I am doing my best to elbow the scandals and revenges which once passed as English history into an obscure career or out of the picture altogether.

But I am not proposing to eliminate history from education far from it. Let me bring down my diagram a stage further and you will see how large a proportion of our treasure of 2,000 hours I am proposing to give to history. This next section represents about 800 to 1,000 pre-adolescent hours. It is the school-boy school-girl stage. And here the history is planned to bring home to the new generation the reality that the world is now one community. I believe that the crazy combative patriotism that plainly threatens to destroy civilization to-day is very largely begotten by the schoolmaster and the schoolmistress in their history lessons. They take the growing mind at a naturally barbaric phase and they inflame and fix its barbarism. I think we underrate the formative effect of this perpetual reiteration of how *we* won, how *our* Empire grew, and how relatively splendid *we* have been in every department of life. We are blinded by habit and custom to the way it infects these growing minds with the chronic and nearly incurable disease of national egotism. Equally mischievous is the furtive anti-patriotism of the leftish teacher. I suggest that we take on our history

from the simple descriptive anthropology of the elementary stage to the story of the early civilizations. We are dealing here with material that was not even available for the schoolmasters and mistresses who taught our fathers. It did not exist. But now we have the most lovely stuff to hand, far more exciting and far more valuable than the quarrels of Henry II and á Becket or the peculiar unpleasantnesses of King James or King John. Archaeologists have been piecing together a record of the growth of the primary civilizations and the developing rôles of priest, king, farmer, warrior, the succession of stone and copper and iron, the appearance of horse and road and shipping in the expansions of those primordial communities. It is a far finer story to tell a boy or girl and there is no reason why it should not be told. Swinging down upon these early civilizations came first the Semitic-speaking peoples and then the Aryan-speakers. Persian, Macedonian, Roman followed one another, Christendom inherited from Rome and Islam from Persia, and the world began to assume the shapes we know to-day. This is great history and also in its broad lines it is a simple history upon it we can base a lively modern intelligence, and now it can be put in a form just as comprehensible and exciting for the school phase as the story of our English kings and their terrestrial, dynastic and sexual entanglements. When at last we focus our attention on the British Isles and France we shall have the affairs of these regions in a proper proportion to the rest of human adventure. And our young people will be thinking less like gossiping court pages and more like horse-riders, seamen, artist-artisans, road-makers and city builders, which I take it is what in spirit we want them to be. Measured by the great current of historical events, English history up to quite recent years is mere hole-and-corner history.

And I have to suggest another exclusion. We are telling our young people about the real past, the majestic expansion of terrestrial events. In these events the little region of Palestine is no more than a part of the highway between Egypt and Mesopotamia. Is there any real reason nowadays for exaggerating its importance in the past? Nothing began there, nothing was worked out there. All the historical part of the Bible abound in wild exaggeration of the importance of this little strip of land. We were all brought up to believe in the magnificence of Solomon's temple and it is a startling thing for most of us to read the account of its decorations over again and turn its cubits into feet. It was smaller than most barns. We all know the peculiar delight of devout people when, amidst the endless remains of the great empires of the past, some dubious fragment is found to confirm the existence of the Hebrews. Is it not time that we recognized the extreme insignificance of the events recorded in Kings and Chronicles, and ceased to throw the historical imagination of our young people out of perspective by an over-emphasized magnification of the history of Judea?

Look at our time-table and what we have to teach. If we give history four-tenths of all the time we have for imparting knowledge that still gives us at best something a little short of 400 hours altogether. Even if we think it desirable to perplex another generation with the myths of the Creation, the Flood, the Chosen People and so forth we haven't got the time for it—any more than we have the time for the really quite unedifying records of all the Kings and Queens of England and their claims on this and that. No reason why much of that stuff should not be picked up in private reading—by those who like that sort of thing. But so far as the school time-table goes we are faced with a plain alternative. One thing or the other. Great history or hole-and-corner history? The story of mankind or the narrow, self-righteous, blinkered stories of the British and the Jews?

There is a lot more we have to put into the heads of our young people over and above History. It is the main subject of instruction but even so, it is not even half of the informative work that ought to got through in this school stage. We have to consider the collateral subject of geography and a general survey of the world. We may have a little mapmaking here, but I take it what is needed most are reasonably precise ideas of the various types of country and the distinctive floras and faunas of the

main regions of the world. We do not want our budding citizens to chant lists of capes and rivers, but we do want them to have a real picture in their minds of the Amazon forests, the pampas, the various phases in the course of the Nile, the landscape of Labrador and so on, and also we want something like a realization of the sort of human life that is led in these regions. We have enormous resources now in cheap photography, in films and so forth, that even our fathers never dreamt of—to make all this vivid and real. New methods are needed to handle these new instruments but they need not be overwhelmingly costly. And also our new citizen should know enough of topography to realize why London and Rio and New York and Rome and Suez happen to be where they are and what sort of places they are.

Geography and History run into each other in this respect and, on the other hand, Geography reaches over to Biology. Here again our schools lag some fifty years behind contemporary knowledge. The past half-century has written a fascinating history of the succession of living things in time and made plain all sorts of processes in the prosperity, decline, extinction and replacement of species. We can sketch the wonderful and inspiring story of life now from its beginning. Moreover, we have a continually more definite account of the sequence of sub-man in the world and the gradual emergence of our kind. This is elementary, essential, interesting and stimulating stuff, and it is impossible to consider anyone a satisfactory citizen who is still ignorant of that great story.

And finally, we have the science of inanimate matter. In a world of machinery, optical instruments, electricity, radio and so forth we want to lay a sound foundation of pure physics and chemistry upon the most modern lines—for everyone. Some of this work will no doubt overlap the mathematical teaching. And finally, to meet awakening curiosity and take the morbidity out of it, we have to tell our young people and especially our young townpeople, about the working of their bodies, about reproduction and about the chief diseases, enfeeblements and accident that lie in wait for them in the world.

That I think completes my summary of all the information we can hope to give in the lower school stage. And as I make it I am acutely aware of your unspoken comment. *With such teachers as we have!* Well I think that it is a better rule of life, *first* to make sure of what you want and then set about getting it, rather than to consider what you can easily, safely and meanly get, and then set about reconciling yourself to it. I admit we cannot have a modern education without a modernized type of teacher. Everything I am saying now implies a demand for more and better teachers—with better equipment. And these teachers will have to be kept *fresh.* It is stipulated in most leases that we should paint our houses outside every three years and inside every seven years, but nobody even thinks of doing up a school teacher. There are teachers at work in this country who haven't been painted inside for fifty years. They must be damp and rotten. Two-thirds of the teaching profession now is in urgent need of being either reconditioned or superannuated. In this advancing world the reconditioning of both the medical and the scholastic practitioner is becoming a very urgent problem indeed, but it is not one that I can deal with here. Presently this section will be devoting its attention to adult education and then I hope the whole question of professional and technical refreshment will be ventilated.

And there is another matter also closely allied to the questions of the rejuvenation of teachers, at which I can only glance now, and that is the bringing of school books up to date. In this informative section of school work there is hardly a subject in which knowledge is not being vigorously revised and added to. Our school work does not follow up contemporary digesting Still less do our school libraries. They are ten, fifteen years out of date with much of their information. Our prison libraries by the by are even worse. I was told the other day of a virtuous prisoner who wanted to improve his mind about radio. The prison had a collection of technical works made for such an occasion and the latest book on radio was dated 1920. There is, I believe, an energetic New School Books Association at work in this field, doing what it can to act in concert

with those all too potent authorities who frame our examination syllabuses. I am all for burning old school books. Some day perhaps we shall have school books so made that at the end of five years, let us say, they will burst into flames and inflict severe burns upon any hands in which they find themselves. But at present that is perhaps—Utopian. It is even more applicable to the next stage of knowledge to which we are now coming.

This stage represents our last thousand hours and roughly I will call it the upper form or upper standard stage. It is really the closing phase of the available school period. Some of the matter I have marked for the history of this grade might perhaps be given in grade B and *vice versa*. We have still a lot to do if we are to provide even a skeleton platform for the mind of our future citizen. He has still much history to learn before his knowledge can make an effective contact with his duties as a voter. You see I am still reserving four-tenths of the available time, that is to say, nearly 400 hours for history. But now we are presenting a more detailed study of such phenomena as the rise and fall of the Ottoman Empire, the rise of Russia, the history of the Baltic, the rise and fall of the Spanish power, the Dutch, the first and second British Empires, the belated unifications of Germany and Italy. Then as I have written we want our modern citizen to have some grasp of the increasing importance of economic changes in history and the search for competent economic direction and also of the leading theories of individualism, socialism, the corporate state, communism.

For the next five-and-twenty years now the ordinary man all over the earth will be continually confronted with these systems of ideas. They are complicated systems with many implications and applications. Indeed they are aspects of life rather than systems of ideas. But we send out our young people absolutely unprepared for the heated and biased interpretations they will encounter. We hush it up until they are in the thick of it. The most the poor silly young things seem able to make of it is to be violently and self-righteously Anti- something or other. Anti-Red, Anti-Capitalist, Anti-Fascist. The more ignorant you are the easier it is to be an Anti. To hate something without having anything substantial to put against it. A special sub-section of history in this grade should be a course in the history of War, which is always written and talked about by the unwary as though it had always been the same, while as a matter of fact—except for its violence—it has changed profoundly with every change in social, political and economic life. Clearly parallel to this history our young people need now a more detailed and explicit acquaintance with world geography, with the different types of population in the world and the developed and undeveloped resources of the globe. The devastation of the world's forests, the replacement of pasture by sand deserts through haphazard cultivation, the waste and exhaustion of natural resources, coal, petrol, water, that is now going on, the massacre of important animals, whales, penguins, seals, food fish, should be matters of universal knowledge and concern.

Then our new citizens have to understand something of the broad elements in our modern social structure. They should be given an account of the present phase of communication and trade, of production and invention, and above all they need whatever plain knowledge is available about the conventions of property and money. Upon these conventions human property stands, and the efficiency of their working is entirely dependent upon the general state of mind throughout the world. We know now that what used to be called the inexorable laws of political economy and the laws of monetary science, are really no more than rash generalization about human behaviour, supported by a maximum of pompous and a minimum of scientific observation. Most of our young people come on to adult life, to employment, business and the rest of it, blankly ignorant even of the way in which money has changed slavery and serfdom into wages employment and how its fluctuations in value make the industrial windmills spin or flag. They are not even warned of the significance of such words as inflation, and deflation, and the wage earners are the helpless prey at every turn towards prosperity

of the savings-snatching financier. Any plausible monetary charlatan can secure their ignorant votes. They know no better. They cannot help themselves. Yet the subject of property and money—together they make one subject because money is only the fluid form of property—is scarcely touched upon in any stage in the education of any class in our community. They know nothing about it; they are as innocent as young lambs and born like them for shearing.

And now here you will see I have a very special panel. This I have called Personal Sociology. Our growing citizen has reached an age of self-consciousness and self-determination. He is on the verge of adolescence. Moral training does not fall within the scope of the informative content of teaching. Already the primary habits of truthfulness, frankness, general honesty, communal feeling, helpfulness and generosity will or will not have been fostered and established in the youngster's mind by the example of those about him. A mean atmosphere makes mean people, a too competitive atmosphere makes greedy, self-glorifying people, a cruel atmosphere makes fierce people, but this issue of moral tone does not concern us now here. But it does concern us that by adolescence the time has arrived for general ideas about one's personal relationship to the universe to be faced. The primary propositions of the chief religious and philosophical interpretations of the world should be put as plainly and impartially as possible before our young people. They will be asking those perennial questions of adolescence—whence and why and whither. They will have to face, almost at once, the heated and exciting propagandas of theological and sceptical partisans—pro's and anti's. As far as possible we ought to provide a ring of clear knowledge for these inevitable fights. And also, as the more practical aspect of the question, What am I to do with my life? I think we ought to link with our general study of social structure a study of social types which well direct attention to the choice of a *metier*. In what spirit will you face the world and what sort of job do you feel like? This subject of Personal Sociology as it is projected here is the school equivalent of a confirmation class. It says to everyone: 'There are the conditions under which you face your world.' The response to these questions, the determination of the will, is however not within our present scope. That is a matter for the religious teacher, for intimate friends and for the inner impulses of the individual. But our children must have the facts.

Finally, you will see that I have apportioned some time, roughly two-tenths of our 1,000 hours, in this grade to the acquisition of specialized knowledge. Individuality is becoming conscious of itself and specialization is beginning.

Thus I budget, so to speak, for our 2,400 hours of informative teaching. We have brought our young people to the upper form, the upper standard. Most of them are now going into employment or special training and so taking on a rôle in the collective life. But there remain some very essential things which cannot be brought into school teaching, not through any want of time, but because of the immaturity of the growing mind. If we are to build a real modern civilization we must go on with definite informative instruction into and even beyond adolescence. Children and young people are likely to be less numerous proportionally in the years ahead of us in all the more civilized populations and we cannot afford to consume them in premature employment after the fashion of the preceding centuries. The average of the population is rising and this involves an upward extension of education. And so you will see I suggest what I call an undergraduate or continuation school, Grade D, the upper adolescent stage, which I presume will extend at last to every class in the population, in which at least half the knowledge acquired will be specialized in relation to interest, aptitude and the social needs of the individual. But the other half will have to be unspecialized, it will have to be general political education. Here particularly comes in that education for citizenship to which this educational section is to give attention latter. It seems to me altogether preposterous that nowadays our educational organization should turn out new citizens who are blankly ignorant of the history of the world during the last twenty-five years, who know nothing of the causes

and phases of the Great War and are left to the tender mercies of freakish newspaper proprietors and party organizers for their ideas about the world outlook, upon which their collective wills and actions must play a decisive part.

Social organization is equally a matter for definite information. 'We are all socialist nowadays.' Everybody has been repeating that after the late Lord Rosebery for years and years. Each for all and all for each. We are all agreed upon the desirability of the spirit of Christianity and of the spirit of Democracy, and that the general interest of the community should not be sacrificed to Private Profit. Yes—beautiful, but what is not realized is that Socialism in itself is little more than a generalization about the undesirability of irresponsible ownership and that the major problem before the world is to devise some form of administrative organization that will work better than the scramble of irresponsible owners. That form of administrative organization has not yet been devised. You cannot expropriate the private adventurer until you have devised a *competent receiver* for the expropriated industry or service. This complex problem of the *competent receiver* is the underlying problem of most of our constructive politics. It is imperative that every voter should have some conception of the experiments in economic control that are in progress in Great Britain, the United States of America, Italy, Germany, Russia and elsewhere. Such experiments are going to affect the whole of his or her life profoundly. So, too, are the experiments in monetary and financial organization. Many of the issues involved go further than general principles. They are quantitative issues, questions of balance and more or less. A certain elementary training in statistical method is becoming as necessary for anyone living in this world of to-day as reading and writing. I am asking for this much contemporary history as the crowning phase, the graduation phase of our knowledge-giving. After that much foundation, the informative side of education may well be left to look after itself.

Speaking as a teacher of sorts myself, to a gathering in which teachers probably predominate, I need scarcely dilate upon the fascination of diagram drawing. You will understand how reluctant I was to finish off at Grade D and how natural it was to extend my diagram to two more grades and make it a diagram of the whole knowledge organization of a modern community. Here then is Grade E, the adult learning that goes on now right through life, keeping oneself up to date, keeping in touch with the living movements about us. I have given a special line to those reconditioning courses that *must* somehow be made a normal part in the lives of working professional men. It is astonishing how *stale* most middle-aged medical men, teachers and solicitors are to-day. And beyond Grade E I have put a further ultimate grade for the fully adult human being. He or she is learning now, no longer only from books and newspapers and teachers, though there has still to be a lot of that, but as a worker with initiative, making experiments, learning from new experience an industrialist, an artist, an original writer, a responsible lawyer, an administrator, a statesman, an explorer, a scientific investigator. Grade F accumulates, rectifies, changes human experience. And here I bring in an obsession of mine with which I have dealt before the Royal Institution and elsewere. You see indicated by this flight of arrows, the rich results of the work of Grade F flowing into a central world encyclopædic-organization, where it will be continually summarized, clarified, and whence it will be distributed through the general information channels of the world.

So I complete my general scheme of the knowledge organization of a modern community and submit it to you for your consideration.

I put it before you in good faith as a statement of my convictions. I do not know how it will impress you and I will not anticipate your criticisms. It may seem impossibly bold and 'Utopian.' But we are living in a world in which a battleship costs £8,000,000, in which we can raise an extra 400 million for armaments with only a slight Stock Exchange qualm, and which has seen the Zeppelin, the radio, the bombing aeroplane come absolutely out of nothing since 1900. And our schools are

drooling along very much as they were drooling along 37 years ago.

There is only one thing I would like to say in conclusion. Please do me the justice to remember that this is a project for Knowledge Organization only and solely. It is not an entire scheme of education I am putting before you. It is only a part and a limited part of education—the factual side of educated--I have discussed. There are 168 hours in a week and I am dealing with the use of rather less than 40 weeks—for 10 years. It is no good saying as though it was an objection either to my paper or to me, that I neglect or repudiate spiritual, emotional and aesthetic values. They are not disregarded, but they have no place at all in this particular part of the educational scheme. I have said nothing about music, dancing, drawing, painting exercise, and so on and so forth. Not because I would exclude them from education but because they do not fall into the limits of my subject. You no more want these lovely and elementary things mixed up with a conspectus of knowledge than you want playfulness in an ordnance map or perplexing whimsicality on a clock face. You have the remaining 162 hours a week for all that. But the spiritual, emotional, aesthetic lives our children are likely to lead, will hardly be worth living, unless they are sustained by such a clear, full and sufficient backbone of knowledge as I have ventured to put before you here.*

*The presidential address of the Section of Educational Science delivered at the 1937 Annual Meeting of the British Association for the Advancement of Science held at Nottingham during the first week of September.

Moscow A Sea Port

Jules Cotte

Since the 1st of May, the Volga-Moscow Canal has been in operation. On the 23rd of March, right to the north of Moscow, the barrage was thrown across the Volga river; its waters, blocked by iron slabs which were lowered simultaneously, overflowed the banks inundating nearly 327 sq. kms. of inhabited and cultivated area.

The canal is now filled with water, making Moscow a central port of the network of waterways of European Russia.

The Network of Waterways of Russia

How can this immense land of Russia prosper and even live when it is perpetually menaced by famine, if the means of transport remain defective? The harvest may be prosperous in the Ukraine while the regions of the north may be ravaged by famine.

The very immensity of the land gives to it a continental climate. Snow covers the land in winter, while the sun burns its plains in summer. No sea breeze refreshes the torrid steppes. The terrain is very flat, so irrigation is difficult; for this reason, a large part of fertile land remains unused for cultivation.

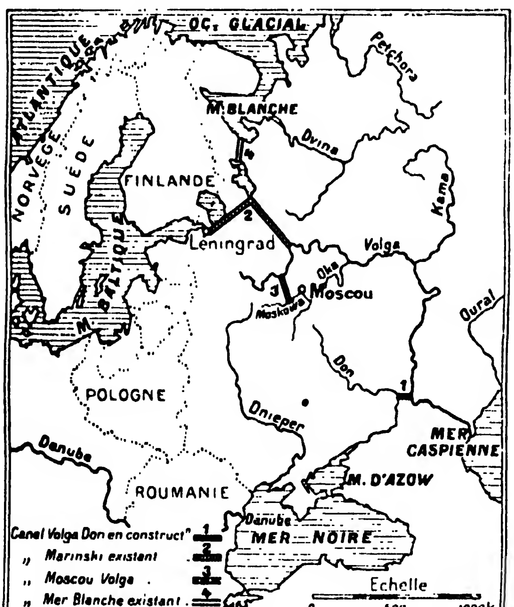
The future of the land depends on the facilities of transport, on supply of raw materials and of finished products as well as on the fertilization of the dry land.

The Soviet Government, solicitous not only for improving agriculture and transport but also for pushing the industrialization of the land, has included in the same plan the production of motive power. The barrage thrown across the course of water shall furnish energy in addition to improving navigation and helping in the development of irrigation.

MOSCOW—A SEA PORT

The programme would appear to be very ambitious if it were not on the verge of being realized. A network of waterways is going to cover the whole of European Russia, and connect each one of its chief cities to the seas which border Russia. These are: to the north the Baltic Sea and the White Sea; in the middle the Caspian Sea, to the south the Sea of Azov and the Black Sea.

If one takes into account Siberia, the total length of waterways which is navigable attains an enormous length of about 4.1 lakhs of kms. in the soviet territorry. The chief arteries are the Volga, the Dwina, the Dnieper, the Irtysh in Siberia, the Lena, the Angara and the Amur.



In 1913, the total length of water-ways which was under control did not exceed 30,000 kms, while now the total length under control exceeds 1. 10 lakhs of kms.

The famous barrage on the Dnieper,* by drowning the rapids and increasing the surface of water has permitted vessels from the Black Sea to penetrate to the centre of West Russia.

In 1933, the canal joining the Baltic to the White Sea had achieved no other result but of connecting the two seas. Now it has connected them to the system of Marinsky canals which are now going to be connected to the Volga and through it to the Caspian Sea.

The Volga approaches within 100 kms. the Don river and the canal which is going to unite the two has been for a long time in the course of construction.

This canal will open a door for Central Russia towards the Black Sea and the Mediterranean Sea, to the basin of the Caspian and the system of Marinsky; These canals along with the Volga and its affluents will serve three quarters of European Russia. The Volga forms the trunk of the network of water-ways and branches on all sides.

The tourists who have travelled down the usual waterway from Gorki (old Nijni Novgord) to Leningrad on comfortable vessels nearly 100 meters in length have admired this immense waterway which is from 1 to 4 km. in width. But they have been annoyed by the Zigzag courses which these vessels have to execute. Probably they do not know that in spite of the small draught of these vessels which scarcely reach 5 meters, these have to glide widely within its banks which are scarcely one meter high from the surface.

If one ascends the Volga towards Kalinin (formerly Tver) the river course, though very straight, becomes inaccessible for these vessels.

They have in contemplation the construction of three dykes which will raise the surface of the Volga and render it navigable for vessels, drawing 4 to 6 meters of water.

The central hydro-electric station constructed upon the barrage shall furnish annually 40 milliards of units of electricity and the water diverted from the river shall irrigate about 4. 3 million hectares of land (one hectar – 2.5 acres).

* The reference is to the great hydro-electric station built on the Dnieper river, and completed in 1935. An account of this great undertaking will be given later.

Reasons for Constructing the Canal Volga—Moscow

It is to these water-ways that the canal connects the capital. Moscow then becomes the central port of five seas washing the Soviet Union to the north, in the middle, and to the south.

Moscow has never been completely isolated. Barges used to come to Moscow from Leningrad by making a long detour round Gorki. But the canal has shortened this way by 1100 kms. It allows passage to vessels of 18 thousand tons and drawing 4 to 5 meters of water.

Its large width of 85 meters allows a velocity of 20 kms. per hour to be realized; while the Kiel canal does not allow more than 6 kms.

Each way a traffic of 15 million tons may be expected.

From the north will come wood and building materials; the volume of traffic will increase with the harvest in the Ukraine; oil from the Donetz basin, fish and salt from the Caspian Sea.

The tourist traffic has commenced from the 1st of May, the day of inauguration. One could see from the marine port of Moscow vessels destined for passenger service down the canal, 12 vessels each accommodating 100 to 300 passengers.

Further, this work presents for Moscow a very particular significance. The capital is very ill-provided with water. It has got a few artesian wells. The canalization brings to them water from the source, but it is the Moscowa river which has furnished the principal. The water is previously treated within a vast basin for purification.

Now the Moscowa did never suffice for the water supply of the capital. In 1932 the gravity of the problem was realized. They made great efforts with 250 kms. of conduit pipes for passing water, which were to give 160 to 168 litres of water per day per head.

But only 30 out of every 100 houses were properly watered. Outside the centre of this city one could see the housewives with their buckets making a long queue round the fountains. When it was hot, the pressure within the conduit pipe fell very low. On the upper storey the occupants vainly opened their taps but there was nothing but a vague sound in the water pipe.

The Canal calls the Volga to the rescue and diverts a good part of its waters to the Moscowa. At present it is possible to distribute 500 litres of water per head per day. A large amount of energy has to be provided for keeping up the water supply; from the point of view of energetics, the canal will do a very good service. The central electric station burns peat and consumes coal from Tula.

With the increase of population, from 2 millions in 1926 to 3.7 millions at present, along with increase of factories, the consumption of energy becomes very important, but the supply becomes very irregular.

It will be necessary to construct other central stations so that the total available power shall come not only to the level of mean consumption, but to that of maximum consumption.

The canal will obviate this inconvenience by serving as an accumulator of energy. The hydro-electric central station of this barrage will fill up the lakes, while Moscow will not have to sacrifice either its motive power or light.

The Canal

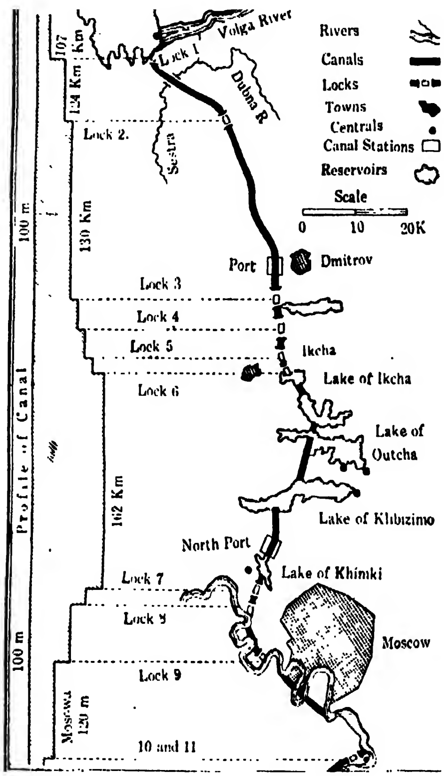
It opens from north to south, and connects the Moscowa and the Volga rivers, at the point where their distance is sensibly the shortest. It passes round the city of Dmitrov and the excavations have shown that this city possessed formerly a wharf. It was then joined to the Volga by a course of water which has been reconstituted.

The canal has traversed the line of water-shed between the basins of high Volga and that of the Moscowa and the Oka rivers. A hill whose height is 40 to 60 meters separate the two basins.

The canal has to be raised in its middle part by 162 meters above the level of the sea, that is to say, 55 meters above the level of the Volga which has a height of nearly 107 meters near the city of Kimry.

MOSCOW—A SEA PORT

It is from this place that the canal starts. A dyke made of earth and stones wedges the Volga against the barrage of concrete 216 meters in length and 22 meters in height.



We have already indicated that as a result of the closing of barrage, 327 sq. kms. of land have been inundated and nearly one billion cubic meters of water have been entrapped. This submerged region has received the name of the Sea of Moscow. Here were an old city of Kortcheva, some villages and estates.

These houses have been constructed at some distance and new land has been given to the peasants.

Round about the barrage the central, hydro-electric station develops a power of 29,000 K.W.H. The canal, having a depth of $5\frac{1}{2}$ meters and width of 85 meters, can receive vessels having a draught of 4 to 5 meters of water.

Its length is nearly 128 kms. But at several stretches it cuts across 5 lakes occupying a total of 19 kms. upon the whole course of 128 kms.

Thanks to six locks, it reaches towards the middle at Ikcha a level of 162 meters: that is, it is nearly 55 meters higher than the Volga in the rear and 38 meters higher than stretch of canal below.

Beginning from the village of Ikcha, it has about the same level as far as Klebnikovo.

From this place 3 locks allow descent of 30 meters. The 10th lock brings it to the level of Moscow which is six meters lower.

But this level itself has been raised with reference to the old level of the Moscowa river because the 11th lock has thrown a barrage across the river, forming a vast lake to the south-east of Moscow.

Hill, rivers, routes, railways—these were the obstacles.

Two hundred detailed pieces of work were required to overcome them. Each one of these is a work of art within the double sense of the word; because the construction has to respond to an object which was technically determined, and also amongst themselves, each presented a particular character and an original stamp.

Amongst the more important, the following may be counted :—

- 11 locks already enumerated.
- 11 barrages isolating the lakes.
- 8 central hydro-electric stations.
- 19 railway bridges.
- 2 tunnels.
- 5 pumping Stations.

The pumping stations are required for filling the different sections of the canal up to the top. The first section after the barrage on the Volga can alone be fed directly. Further, as we have already noticed, the pumps divert to the Moscowa river a part of the Volga waters for the needs of Moscow. The pumps are extremely powerful, each one being able to deliver 20 cubic meters of water per second.

One of the vast lakes will impound 114 million cubic meters of water which is sufficient for feeding

Moscow for one month in case the pumping stops. A particular canal, 31 kms, in length, shall join the lake to the suburbs of the capital, where the water will be swallowed within subterranean conduits.

As it has already been noted, the pumps shall function only at those moments when the network of municipal electric lines have got only feeble load; outside these hours, all the hydro-electric stations shall work for the network of canals.

One port has been constructed opposite Dmitrov while Moscow possesses two ports.

Near Khimki, there is the north port with a central electrical station in two steps riveted by granite, marble and diorite. At its extremities are large sections receiving a jet of water,

The northern section contains polar bears, the south the dolphin of the Black Sea.

To the south of Moscow, a lake forms the water station. Naturally the stations are provided with modern materials, engines and powerful and diverse implements.

Construction

In September 1933, the first workers arrived. The total work has lasted for 3½ years, 152 millions cubic meters of earth have been removed and 2. 95 lakhs of cubic meters of concrete have been prepared on the spot by 15 factories and by hundreds of cement works.

The transport was assured by 161 locomotives, 225 tractors and 3050 wagons. Within the workshops there were 5, 000 motors and 50, 000 workers.

The total cost was nearly 2 milliard roubles (about 300 crores of rupees). The work has been prepared with great care.

For the first study alone the aeroplanes took 5000 photographs of different sections of the area.

At Dmitrov was installed an experimental station. Thousands of experiments were performed upon 80 models of pumps before actually adopting any particular apparatus. These pumps have been all constructed in the country.

All the materials utilized have been manufactured in the U.S.S.R. which has pledged itself not to utilize anything but the resources of the country and also to the task of making the canal the most beautiful in the world.

The artistic side has not been neglected. Towers shoot up here and there. The canal itself has been ornamented by bas reliefs, *e. g.*, there is one representing the struggle for the flag.

This bas relief illustrates the efforts of different bands of workers, competing amongst themselves for securing maximum production.

The victorious band gets the red flag, just as the *Normandie* struggles to have the blue ribbon of the Atlantic.

The workers themselves have celebrated the feast of the canal by a volume of verse. They have edited a journal called *The Assault on the Canal*.

The workers were followed by savants who surveyed the excavations; but in this country, where wood has hitherto formed the chief building material, the archaeological discoveries have not been very important.*

* * * * *

In resuming the subject, we can say that the completion of the canal has furnished Moscow with water of which it has need, regularized its power supply, and has rendered the capital the centre of the network of waterways of the Soviet Republic.

The network of waterways, taken as a whole, will permit the fertilization of the soil, and put the important localities in the Soviet Republic in communication with the ports for other countries. In times of peace, it will facilitate and promote commercial intercourse. The creation in Russia of a gigantic network of navigable waterways, accessible in its largest arteries to vessels of large tonnage, constitutes an economic fact of great importance, not only for Soviet Russia, but also for the whole of Europe. One cannot estimate now their full consequences; but they can be sensed all right. In time of war, large vessels can be transported by means of these waterways from the Black Sea to the Baltic Sea, thanks to the new Volga-Moscow canal.

* Translated from *La Nature*, August 1937

A Critique of the New Ideas on Examination

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Criticism of the Old Type of Examination

(*i*) *Variability of Judgment.* In 1913, Professor Starch[1] a well-known worker in the field of educational psychology had an answer book of a high school student in geometry examined by 115 teachers of mathematics at different high schools. The marks ranged between 28 and 92. A similar situation was found in several other fields of study. It was felt that a more objectively valid procedure was needed.

(*ii*) *Complexity of Judgment.* The questions in the usual type of examination are such that they have to be answered in the essay form. No simple judgment of value is, therefore, possible. The attention of the examiner oscillates between the materials presented, the style of writing and the plausibility of presentation. Any one of these features may determine the award.

(*iii*) *Emphasis on Language.* It follows, then, that the essay-type of examination favours those possessing better linguistic equipment. The linguistic ability, however, is only one out of the many capacities that success in life or in the university demands. Hence, a test which puts a premium on the language is not necessarily a fair test.

(*iv*) *Undetermined Difficulty of the Test.* The old type of examination must keep its question paper secret. Not only the specific items in the paper, but also its general form, remains unknown. How far a particular question paper is suitable for a group of students is not objectively determined. There is no standard of the difficulty of the paper apart from the subjective feeling of the examiner. This fact also stands in the way of accepting the examinations as objective measures of ability

(*v*) *Want of Internal Correlation between the several items of a paper in the essay type of Examination.* The essay-type of examination paper gives a summative view of a number of specific achievements. Success in one item bears no relation to success in another. This can be expressed in the statement that the *self-correlation* of the essay type of examination is very low. As a matter of fact, according to Gates[2], the value of the R (correlation) in the papers considered by him is only ·36. This implies that a paper of this nature does not bring into play a unitary set of mental functions.

Substitutes for the Traditional Types of Examination

(*i*) *Interview.* Interview has been a common method of selection of employees in all industrial concerns. The choice has often been justified by later achievements. It was, therefore, thought that this method could, to a large extent, substitute or supplement the usual type of examination. A regular technique of interview gradually developed and the psychologist in early twenties began, for a time, to assay the validity of this method.

(*ii*) *Mental Tests.* Pari passu, there developed another technique, namely, the evaluation of students educational possibilities in terms of mental tests. The Army Alpha tests in America had yielded striking results. It had been found that persons who had higher scores in these tests proved better soldiers in most of the instances. It was also found that the arrangement according to

1. Ballard, ***The New Examiner***, p. 182 (Hodder and Stoughton, 1929.

2. Gates, ***Journal of Educational Psychology***, May 1921, p. 276-287.

rank in subsequent professional examinations in the army had a marked correspondence with the 'rankin' on the basis of the Army Alpha scores. The mental tests were thus regarded as supplying a better objective basis than the usual essay type of examination. This view soon gained ground. A large number of tests were formulated and standardized. Each tried to improve upon the technique of its predecessors. For a time, there was a great confidence in the validity of these tests and on the method of selection based on them.

One difficulty, however, was soon pointed out. Before a student is permitted to proceed from one type of institution into a higher grade, he must show a minimum knowledge of particular subjects such as languages, history and arithmetic. Mental tests indicate the *native intelligence*; they do not measure the degree of special knowledge.

A second difficulty was also perpetually before the psychologists. The different sets of tests, though they claimed to measure the same capacity, namely general intelligence, did not always show a very high degree of correlation[3]. It was found, for instance, that the difference in I. Q. as measured by the Hering-Binet test and the Stanford Revision test amounted to 17·2. Hence, there was a feeling that there should be a better contrivance for selection of educational purposes.

(*iii*) *Psychological Examination*: This feeling of uncertainty in regard to the validity of tests led to the formulation of what is known to-day as "Psychological Examination". The purpose of this examination is to present the materials of a particular subject in the form of mental test.

Its Different Forms: There are several well-known forms of psychological examinanion. The usual forms applied in America are (1) the Thorndike psychological examination, (2) the American Council psychological examination, and the (3) Thurstone psychological examination. In Great Britain Ballard's psychological examination is in frequent use.

Its General Character: The different forms of psychological examination differ in the details of materials, in the number of items and the method of scoring. The general nature of the items, however, is about the same in the different varieties of the examination.

The items of a Psychological Examination: The materials of a psychological examination are usually presented under the following heads: (*i*) completion test, (*ii*) multiple choice tests, (*iii*) True-false tests, (*iv*) Re-construction tests, and (*v*) analogy tests. Ballards history test presents these items in the following way:

Ballard's History Test: a Sample of Psychological Examination: 1. When did the following events take place? (*i*), (*ii*), (*iii*), (*iv*), etc. The dates will be found among those given below. Write the No. of the event against the date.

2. Choose from among the names in the brackets the one that will make the statement true:

e.g., The Prima Minister of England just after the secession of and during the time of the French Revolution was – (William Hitt, Robert Walpole, Robert Peal, W. E. Gladstone).

3. Completion test:

e.g., England first became protestant in the reign of

4. Placing names and events in order of priority

5. Some of the following sentences are true, some are false. Underline the true sentences.

6. Underline sentences which you believe to be entirely true:

e.g., The suppression of the monasteries by Henry VIII proved of benefit to the poor.

Such tests have been formulated for all subjects. The total number of test items is usually one hundred. The time allotted is usually an hour or less. There is thus a considerable economy of time.

Special Advantages claimed for such Examinations: The new type of examination has been ushered into existence on account of the defects of the essay type of examinations. It is reasonable to

3. Caroll, H.A. and Holling Worth, L. S.. The systematic error in Hering-Binet in testing gifted children. *Journal of Educational Psychology*, 1930, No. 21, p. 1-11.

suppose, then, that the usual defects of the traditional system of examination would not be found in the new type.

(*i*) It is pointed out that psychological examination can be standardized. Its difficulty can be suited to the attainments of the student. Hence, the *chance factor* is to a great extent eliminated.

(*ii*) This type of *examination* brings out at once the facts of *native intelligence* and amount of information. At the same time it excludes other adventitious factors.

(*iii*) The *self-correlation* of psychological examination items is high. Gates, to whose view reference has already been made, finds it to be ·54.

(*iv*) This type of examination throws main responsibility of the examination on the maker of the test. The paper examiner has only a mechanical task to perform. Hence, a particular candidate has *less chance* of suffering from an *error of judgment.*

(*v*) It is found that repetition of the same kind of test in the new type of examination brings out a better correlation between a test item and intelligence *quotient*. It is thus claimed that each repetition brings out as it were a fresh display of the intelligence factor. This does not hold true of the essay type of examination. The following tables[4] will illustrate the point :

TABLE. 1

Correlation between	2	True-false tests and Intelligence test...	·432
Correlation „	3	„ „ „ „ „ „ ...	·472
Correlation „	4	„ „ „ „ „ „ ...	·508
Correlation „	5	„ „ „ „ „ „ ...	·515

TABLE. 2

Correlation between	2	essays and intelligence	·340
Correlation between	3	„ „ „	·344
Correlation „	4	„ „ „	·350

Ballard[5] holds out high hopes for the new type of examinations and intelligence tests. "For most of the purposes," he says, "for which public examinations are held, an intelligence test is of more significance than an attainment test. It is more significant because it affords a clearer and more conclusive index of that the testee is likely to achieve in years to come. It is a promise of the future and not merely an epitome of the past".

Tests and New Types of Examination and Their Application

It was not in the spirit of reform alone that educationists proceed to employ these new methods. These appeared to promise an easy solution of certain pressing problems. One instance is the question of selection of candidates for scholarships. An error of judgment may spoil a career. Hence the authorities desire to be as free from error as possible. Another instance is to be found in the admission of students to institutions when the number of candidates far exceeds the limits of the class. It would be useful to survey these cases in brief.

(*a*) *Bradford.* Bradford Education Authority adopted a set of group tests (written) for the purpose of award of scholarships in 1919.

(*b*) *Northumberland.* Professor Godfrey Thomson, a leading authority in this field, devised a set of group tests for discovering "promising young men who would be likely to profit by a course of training in High Schools". The Northumberland Education Authority had found that about one third of the schools, mostly lying in the rural areas, sent no student for the ordinary scholarship examination. The tests were given in order to discover talented pupils of these backward schools. Due to bad teaching or due to unfavourable home conditions pupils from these institutions could not compete in essay writing and arithmetic. The test-

4. Ballard, *Op. cit.* p. 64.
5. Ballard, *Op. cit.* p. 26.

were intended to discover native talent rather than scholastic achievement. The latter was admittedly not up to the mark. It was found that of twenty pupils selected on the ground of intelligence, *nine* took first place in their respective classes in secondary schools and eleven took second or third places.[6]

(*c*) *Cheltenham Grammar School and Blackpool.* Dr Ikin, the Education Officer at Blackpool, has attempted to make selections for junior county scholarships with the help of mental tests. He seems to be satisfied with the working of his scheme. At Cheltenham Grammar School tests were applied to candidates both for scholarship examination and for *entrance examination.* There seems to be a high percentage of correlation between these results and those obtained by independent examination or by interview.

(*d*) *London Day Training College. Test Scheme.* The London Day Training College is said to admit students on the basis of tests. I have very little information in regard to the nature of these tests or their success.

(*e*) *The Columbia Scheme. Psychological Examination.* The Columbia University has for some time applied the *Thorndike psychological examination* to intending candidates for admission. The selection on the basis of this test is said to have greatly improved the quality of freshmen.[7]

6. Rex Knight, *Intelligence and Intelligence testing* (Methuen 1933) p. 89.

7. Rex Knight, *Op. cit.* p. 91.

(*f*) *Chicago Scheme. Psychological Examination.* The University of Chicago offers a *Psychological examination* consisting of the following items :

(*i*) Information on the course studied.

(*ii*) General information about the field.

(*iii*) Advanced knowledge beyond that giver in the course.

(*iv*) Items that test reasoning power within the field.

(*v*) Typical intelligence test items within the field.

(*vi*) Trick questions. The general report seems to indicate satisfactory working of the scheme[8].

(*g*) *Hamburg, Germany : A mixed plan.* Wilhem Stern, the noted German psychologist, developed a test programme for selecting pupils for special training. This scheme, however, differs from the others mentioned above. The selection is made on the basis of four sets of data, certain mental tests (quality tests rather than speed tests), standardized teachers' observation, parental judgments and children's inclination. The scheme is said to be working with great success. It should be noted here that both the purpose and the method of this examination are very different from others discussed in this context. The purpose for which selection is made is for special training in certain lines bearing of vocations[9].

(*To be concluded*)

8. Stalnaker and Richardson, Scholarship Examinations *Journal of Higher Education* 1934, No. 5, p. 305-313.

9. Meyer, A.E. *Germany and the I. Q. School and Society*, 1926, No. 24, p. 410-415.

The History of Evolutionary Thought

As Recorded in Meetings of the British Association

Sir Edward B. Poulton

President of the British Association Meeting for 1937.

Sir William Thomson, in his Address at Edinburgh in 1871, said that 'the real origin of the British Association' was given in the words of a letter written by David Brewster to John Phillips on February 23, 1831, a few months before the first meeting: 'The principal object of the Society would be to make the cultivators of science acquainted with each other, to stimulate one another to new exertions, and to bring the objects of science more before the public eye, and to take measures for advancing its interests and accelerating its progress.' That the time was fully ripe for the birth of the Association is made very clear by the words written by John Keble to a friend, referring to the D.C.L. degrees conferred, at the Oxford meeting in 1832, on David Brewster, Robert Brown, John Dalton and Michael Faraday: 'The Oxford Doctors have truckled sadly to the spirit of the times in receiving the hodge-podge of philosophers as they did'—an opinion on which Lord Salisbury commented at the Oxford meeting in 1894: 'It is amusing at this distance of time, to note the names of the hodge-podge of philosophers whose academical distinctions so sorely vexed Mr. Keble's gentle spirit.' It is not only amusing but pathetic that such words should have been used by a revered member of a University which had done splendid service for science, as has been so well shown in Dr. R. T. Gunther's volumes.[1]

Faced by the serious duty of preparing this address, I felt that the best hope of interesting you would be to choose a subject which has received special attention at our meetings. I have selected the progress of thought on Organic Evolution as it may be followed in addresses, papers, and discussions, mainly restricting myself to the series of meetings which began with the Jubilee at York in 1881, the first of many that I have had the pleasure of attending.

The British Association provides a very favourable field for the discussion of many-sided subjects such as Evolution—subjects which attract members from very different as well as from closely related Sections. Hence a wide range of varied experience is open to one who can look back over more than half a century; and I do not propose to exclude some of the humorous sayings and incidents which, from time to time, have enlivened our meetings and contributed to their success. Some of them certainly deserve to be rescued from oblivion, although to perform this pious duty I must risk the enmity of the Goddess of Folly, who as Erasmus tells us, proclaimed: 'I hate a man who remembers what he hears.'

The Fiftieth Anniversary at York was a memorable meeting, with Sir John Lubbock (Lord Avebury) as President, and the Chair of every Section except Economics, under Grant Duff, taken by a Past-President of the Association.

I then enjoyed to the full one of the chief benefits conferred by our Association upon its younger members—the opportunity of meeting older men, up to that time only known to them by the fame of their discoveries. Prof. O. C. Marsh had come over from Yale, his main object being to buy for his University Museum the second and more perfect fossil of the wonderful ancestral bird Archæopteryx, with teeth and a long, lizard-like tail—clear evidence of Reptilian origin. The earlier example had been bought for the British Museum at a price which was said to have provided the dowry for a professor's daughter, and Marsh soon realised, as he told me, that the second was for sale on any terms. 'We let the other go and I believe they would kill me if this were sold' was the reply given to him by the authority in Munich. He was, however, able to study the fossil, and his description and drawings of the teeth, in the Geological Section, followed the only attack on Evolution itself, as distinct from its causes, which I have ever

[1] *Early Science in Oxford*, vols. i-xi.

witnessed at any of our meetings. It was the exhibition by H. G. Seeley of his reconstruction of Archæopteryx from this fossil, which aroused the fury of the palæontologist, old Dr. Thomas Wright of Cheltenham: 'Archæopteryx hasn't got a head, how can it possibly have teeth?' he growled, knowing nothing of the latest find or of the fact that a detached head and scattered teeth had been detected on the slab in which the older specimen was embedded. In spite of Prof. Newton's positive statement and the form of the teeth, drawn by Prof.Marsh at the request of the Chairman, Dr. Wright, quite unconvinced, continued muttering 'Archæopteryx is a very good bird,' its virtue in his opinion entirely uncontaminated by any taint of Reptilian affinity.

Prof. Marsh also read a paper in the Zoological Section on his own wonderful discoveries of toothed birds from the rocks of the western United States. Richard Owen, President of the Section, was in the Chair and, with the memory of old and embittered controversies in his mind, the author told me that he had felt rather anxious in bringing this communication forward. But in that friendly atmosphere there was no reason for alarm. Owen welcomed the paper warmly and in confirmation told us, in the most charming manner, of the traces of teeth found in an embryo parrot.

The event which stands out most clearly in my memories of the Jubilee meeting is Huxley's evening lecture on 'The Rise and Progress of Palæontology' —the science which provides an essential part of the foundation on which Geographical, Geological and Biological evolutionary history has been built. The insuperable difficulty felt by the older naturalists was to believe that the land had been for the most part deposited under the sea, and to account for the presence of fossils, or as they were called, 'formed stones.' The true solution, Huxley explained, was found and published in 1669 by Nicholas Steno, a Danish Professor of Anatomy at Florence, who carefully studied certain fossils, known as 'glossopetræ' which corresponded in every particular with the teeth—'that in fact they were shark's teeth.' The emphasis with which Huxley made this statement comes back to me after the lapse of nearly sixty years. From this Steno was led to conclude that they were the teeth of shark-like fishes living in the Tuscan sea and later embedded, with other remains, in the strata which had there accumulated.

I have not noticed the fanciful suggestion of 'fossil fig leaves' in any published version or account of Huxley's lecture that I have seen, but he certainly told us of it and it is an interesting example of the attempts made by the naturalists of the day to explain the fossils embedded in rocks then believed to be of terrestrial origin. I cannot resist the temptation of quoting Plot's[2] more ingenious and amusing effort to account for the well-known layer of oyster-shells *(Ostrea bellovacina)* found '....at some places here in *England*, particularly at *Cats-grove* [now Katesgrove] near Reading .... ; which how they should come here without a *Deluge*, seems a difficulty to most men not easily avoided'.

Plot was, however, helped 'to a *salvo*' for his own objection by remembering that Reading was 'a *Town* of very great *action* during the *Invasions* of the *Danes*, who cutting a deep trench cross between the *Kennet* and *Thames*, and inclosing themselves as it were in an *Island*, held it against King *Ethelred*, and *Alfred* his Brother a considerable time; from whence in all probablity, the *Saxons* having removed their *Cattle* and other provisions before the *Danes* arrival, its likely that they might be supplied from their *Navy* on Land, might be very suitable employment for it: Which conjecture, if allowed, there is nothing more required to make out the possibility of the bed of *Oysters* coming thither without a *Deluge*, but that *Cats-grove* was the place appointed for the *Armies* repast.'

The probability of this suggestion may be inferred from the age of the 'Woolwich and Reading' beds in which the oysters are found—estimated by my friends Prof. Watts and Prof. Hawkins at about 50 to 60 million years.

Dr. Plot's explanation of fossils in general as well as of flowers was of a very different kind. To account for their existence he appealed to 'the wisdom and goodness of the *Supreme Nature*, by the *School-men* called *Naturans*, that governs and directs the *Natura naturata* here below, to beautifie the

[2] *The Natural History of Oxfordshire, being an Essay toward the Natural History of England,* by Robert Plot D.D. Printed at the Theater in Oxford. 1677. Dedicated To the most Sacred Majesty of Charles the Second, King of Great Britain, France and Ireland, Defender of the Faith, etc. (pp. 118-122).

World with these varieties: which I take to be the end of such productions as well as of most *Flowers*, such as *Tulips*, *Anemones*, &c. of which we know as little use as of formed stones.'

The modest and withal amusing paragraph which follows I venture to quote in full as an example to be followed in scientific controversy:

'And thus I have given the grounds of my present *opinion*, which has not been taken up out of *humor* or *contradiction*, with intent only to affront other worthy Authors modest conjectures, but rather friendly to *excite them*, or any *others*, to endeavor collections of *shell-fish*, and parts of other *Animals*, that may answer such *formed stones* as are here already or may hereafter be produced: Which when ever I find done, and the reasons alleged *solidly* answered, I shall be ready with acknowledgment to retract my *opinion*, which I am not so in love with, but for the sake of *Truth* I can cheerfully cast off without the least reluctancy.'

One chief object which, as I believe, Huxley had before him was to bring forward a calm, clear statement of the evidence on which alone it was possible to achieve that 'reconstruction of an extinct animal from a tooth or bone,' which had made so deep an impression on the imagination. The reconstruction was in fact a simple inference based on anatomical experience such as that gained by Steno when he dissected the shark and concluded that the 'glossopetræ' were the teeth of shark-like fishes. But this reasoning—that a fossil tooth or bone on the surface of a rock, cannot by itself enable the geologist to predict that a skeleton of a certain type lies hidden beneath—seeming to diminish the glory of Cuvier's splendid work, was resented by Owen who had replied with the bitter taunt that a tooth can tell us a great deal - a donkey can kick his master but he cannot eat him. This may have been the encounter referred to by Huxley when he wrote of a friendly meeting with Owen at the Zoological Section of the Association in Leeds (1858): 'so that the people who had come in hopes of a row were (as I intended they should be) disappointed.'[3] In the same spirit, I think, Huxley was glad to speak of the 'glossopetræ' at the Jubilee meeting, where Owen was President of a Section, and calmly and simply, to reaffirm conclusions which are unassailable.

Huxley then passed on to Steno's further study of fossils and his proof of their relationship to terrestrial freshwater and marine organisms, and to his application of this evidence to the past condition of Tuscany—all discussed 'in a manner worthy of a modern geologist' and later extended by Buffon to all parts of the world then known to be fossiliferous. These conclusions, 'which almost constitute the framework of palæontology,' only required one addition, made towards the end of the eighteenth century by William Smith, who showed that geological strata contained characteristic fossils so that rocks of the same age could be identified in all parts of the world, while the biologist could follow the changes in the living population of the globe—a record of constant extinction and continual generation of new species. We were then led to three general conclusions: (1) the vast length of time during which life has existed on the earth—'certainly for millions of years'; (2) the continual changes which living forms have undergone during this period; (3) the successive changes in the best-known fossil groups are such as we sholud expect if each series 'had been produced by the gradual modification of the earliest form. . . ' This last conclusion meant evolution which so completely accorded with recent discoveries that 'if it had not existed the palæontologist would have had to invent it.'

I can never forget the words spoken to me after the lecture by a dear friend of my youth, the late Viriamu Jones, Principal of University College, Cardiff: 'At every sentence I felt myself bowing to Huxley and saying " you are the greatest man here; no one else could have said that you have said it." '

As Huxley's lecture continued in a calm spirit an embittered controversy, so his thoughts on the immensity of past geological and biological time lead naturally to another controversy on the age of the earth conducted intermittently at our meetings between 1892 and 1921. It is, I think, a good example of the invaluable help which the British Association brings to discussion when there appears to be a difficulty in reconciling the conclusions reached by the fellows of different science. Lord Kelvin's estimate of a hundred million years as the period during which the earth had been cool enough

[3] *Life and Letters*, vol. i, p. 177.

to permit the existence of life upon its surface a period reduced by Prof. Tait to ten million—was a great difficulty to geologists and biologists who believed an immensely longer time was required for the history of the fossiferous rocks and the evolution of animals and plants. Thus, to quote only one instance, Darwin writing to Wallace in 1871 and referring to 'missing links,' said, 'I should rely much on pre-Silurian time; but then comes Sir William Thomson, like an odious spectre.' The geologists resisted more firmly. Thus Sir Archibald Geikie, in his Presidential Address at Edinburgh in 1892, concluded his discussion of the subject with these words: 'The geological record furnishes a mass of evidence which no arguments drawn from other departments of Nature can explain away, and which, it seems to me, cannot be satisfactorily interpreted save with an allowance of time much beyond the narrow limits which recent physical speculation would concede.' At the Leeds meeting in 1890 I had many opportunities of meeting Prof. John Perry, and when we were walking together on the Sunday afternoon I asked him to tell me something of the Kelvin-Tait conclusions and how far they must be accepted. He had been a demonstrator under Kelvin and spoke of the intense interest with which he had followed his lectures at Glasgow, and he gave me no hope of escape. His change of opinion, throwing a most interesting light upon the influence of the British Association, was the result of the Presidential address at Oxford in 1894, when Lord Salisbury chaffed the believers in natural selection, telling them that he did not wonder that they required many hundred million years for so slow a process, but that 'if the mathematicians are right, the biologists cannot have what they demand. . . The jelly fish would have been dissipated in steam long before he had a chance of displaying the advantageous variation which was to make him the ancestor of the human race.' When Perry read this pronouncement, sweeping aside the firm convictions of biologists and geologists, he was led to re-examine the evidence and soon found a flaw. The heat of the earth had been calculated on the assumption of a conductivity uniform through the whole mass, but Perry showed that with a conductivity becoming higher with increasing depth the Kelvin-Tait estimate of the time required for cooling to the existing temperature—on which the age of the habitable earth had been based—must be immensely lengthened. Perry told me of this destructive criticism and very kindly helped me to make use of it in the address to Section D at Liverpool in which I replied to Lord Salisbury's amusing attack on the evolutionists.

Lord Lister was our President at Liverpool in 1896, and I cannot resist the temptation to digress for a moment and recall the address in which one of the greatest benefactors of mankind told us, with the utmost simplicity and modesty, the story of his life's work and the success which, in spite of all opposition, had been achieved. To hear him was an enduring inspiration.

The year 1896 was also the Jubilee of Lord Kelvin's wonderful half century of achievement in research and teaching, and I could not help feeling some regret that any criticism of his work should appear at this particular time. But in the kindly spirit of our Association such doubts were quite unnecessary. I well remember how he came one day to our Sectional Committee-room to bring me some volumes of his works, and how as I have recorded before, in the following year as we were travelling across Canada after the Toronto Meeting and the chance of collecting insects for a few minutes at each station could not be resisted, Lord Kelvin said to his wife, 'My dear, I think we must forgive Poulton for thinking that the earth is so very old when he works so hard in one day out of all the endless millions of years in which he believes!' [4]

The one line of evidence which left some anxiety in 1896, was suggested by Helmholtz who allowed the sun only eighteen million years to have been giving out radiant heat at the present rate—a period Lord Kelvin was willing to extend to 500 million—and this estimated maximum was also accepted by Sir George Darwin, who in his address [5] at Cape Town in 1905, spoke of the new evidence obtained by M. and Mme. Curie in their proof that radium gives out heat, and quoting in confirmation the work of R. J. Strutt, W. E. Wilson, and G. H. Darwin, finally concluded that 'the physical argument is not susceptible of a greater degree of certainty than that of the geologists, and the scale of geological time remains in great measure un-

[4] *Report, British Association, Centenary Meeting,* 1931, p. 78.

[5] *Report, British Association,* 1905, pp. 514—518.

known.' The light thrown by radium upon the Helmholtz estimate was also referred to in the Presidential Address of Ray Lankester at York in 1906, of J. J. Thomson, quoting the work of Strutt, Joly and Rutherford, at Winnipeg in 1909, and became a predominant subject in the Joint Discussion on the Age of the Earth, between Sections A, C, D and K, at Edinburgh in 1921.[6] Lord Rayleigh in opening this discussion concluded 'that radioactive methods of estimation indicate a moderate multiple of 1000 million years as the possible and probable duration of the earth's crust as suitable for the habitation of living beings...'

Even in the present year Sir Ambrose Fleming, in his address to the Victoria Institute, is reported in *The Times* of January 12 to have maintained that 'We were not in possession of any generally agreed scientific modes of geological time measurement, but only with estimates which were based for the most part on personal predilection or guesses at truth.' It is to be regretted that the conclusions of scientific colleagues should be attributed to 'personal predilection,' and as for 'guesses at truth'—what are these but hypotheses; and surely the discoverer whose imaginative effort led to the thermionic value and did so much to endow the world with the infinite possibilities of wireless · surely he has little cause to choose for the serious efforts of others the word which in this connection carries a suggestion of shallow irresponsibility. Geologists and biologists do not profess to know the *age* of the earth as the abode of life, but they are sure that, in the words used by Sir William Turner at Bradford in 1900, its birth 'must have been in the far-distant past, at a period so remote from the present that the mind fails to grasp the duration of the interval.'

I fear that too much of our time has been occupied by the attempt to show that the field is clear for the discussion of Arganic Evolution, but until this could be done any such discussion appeared to be well-nigh useless.

It is, I think, a mistake to emphasise too strongly the very natural shock received by many who read the *Origin* or heard of its teaching for the first time and without any preparation; and I believe an even greater mistake to criticise the clergy for the time that elapsed before their acceptance of the new teaching. I shall never forget the reception of Aubrey Moore's paper, 'Recent Advances in Natural Science in their Relation to the Christian Faith,' by the Church Congress at Reading in 1883.[7] No speaker should have carried his audience with him more thoroughly: there was not a single protest or indication of dissent—nothing but enthusiastic applause. The Bishop of Oxford, Dr. Mackarness, was in the chair when the paper received this unanimous welcome—only twenty-three years after the Oxford meeting at which another Bishop of Oxford put his rude and foolish question to Huxley. It is pleasant to know that their celebrated encounter left no bitterness, for Huxley wrote in 1891 to Francis Darwin—'In justice to the Bishop, I am bound to say that he bore no malice, but was always courtesy itself when we occasionally met in after years.'

I remember as a youth receiving a gentle parental warning against committing myself too entirely to a belief in evolution—a very different experience from that of our President at Hull in 1922, my friend Sir Charles Sherrington, who in 1873 was persuaded by his mother to take the *Origin* with him on his summer holiday, with the inspiring words—'It sets the door of the Universe ajar!'

I have already recalled Dr. Wright's indignation at York in 1881 as my only experience of opposition to a belief in Organic Evolution at any of our meetings, and the published Proceedings confirm this impression of unanimity. Thus, R. H. Traquair addressing the biologists at Bradford in 1900, said, 'I hardly think that we should now find a single scientific worker who continues to hold on to the old special creation idea'; and Lord Salisbury at Oxford in 1894, referring to Drawin, said, 'He has as a matter of fact, disposed of the doctrine of the immutability of species. It *has* been mainly associated in recent days with the honoured name of Agassiz, but with him has disappeared the last defender of it who could claim the attention of the world.' The mention of this great American naturalist recalls Tyndall's fine address at Belfast in 1874 and his memories of Agassiz's words, I was not prepared to see this theory received as it has been by the best intellects of our time. Its success is greater than I could have thought possible.'

Huxley, who had seconded the vote of thanks to Lord Salisbury, wrote to Hooker a few days later:

[6] *Report, British Association,* 1921, pp. 413–415.

[7] *Science and the Faith,* London, 1889, pp. 222–235.

'It was very queer to sit there and hear the doctrines you and I were damned for advocating thirty-four years ago at Oxford, enunciated as matters of course—disputed by no reasonable man!—in the Sheldonian Theatre by the Chancellor......'[8]

A letter written two days earlier to Boyd Dawkins records Huxley's opinion of another part of the address. 'Lord Salisbury gave himself away wonderfully, but he was so good about Darwin himself that I shut my eyes to all the nonsense he talked about Natural Selection.'[9]

Leaving now the subject of Organic Evolution itself, as generally accepted, I wish to speak on the difficult question of its motive causes which for many years have formed the subject of addresses, discussions and papers at our meetings. The great division into two opposed theories of causation became clear in 1887 when Weismann attended the meeting at Manchester, and a discussion on 'The Hereditary Transmission of Acquired Characters' was held in Section D. From that time evolutionists attending our meetings have been either 'Lamarckians,' following Erasmus Darwin, Lamarck, Buffon and Herbert Spencer, or 'Darwinians' who followed Darwin and Wallace. Darwin himself, however, included the Lamarckian conception of 'use-inheritance' as motive cause, although believing it to be far less important than Natural Selection. The term 'Neo-Darwinian' has therefore been applied to those who, accepting Weismann's teaching, reject 'use-inheritance' altogether.

It must always be remembered that, apart from any theory of cause, the world owes its belief in organic evolution to all the great men whose researches and teaching have founded the two schools, and perhaps chiefly, at any rate among the English speaking nations, to Herbert Spencer. I was first led to realise the extent of his transatlantic popularity when I learned from an American story greatly enjoyed in those far-off undergraduate days, that his books were keenly appreciated by a bashful hero, who was so far from sharing the sublime confidence of their author, that he was only led to perform the most fateful action in life by the pressing advice of a very young nephew who assured him, in the presence of the lady, that if he was fond of her, the proper thing to do was to kiss her. Herbert Spencer's infallibility certainly lent itself to such stories as that of his supposed reply to an argument—'That can't be true, for otherwise *First Principles* would have to be re-written—and the edition is stereotyped'; or how Darwin said that to read Spencer always made him feel like a worm, but that he retained the worm's privilege of wriggling, and at another time 'wonderfully clever, and I dare say mostly true.' But, allowing for a style which provoked these and other amusing comments, we must never forget that believers in the doctrine of Organic Evolution owe an immeasurable debt to Herbert Spencer.

James Russel Lowell's amusing lines in the *Biglow Papers*[10] appear to prove that Lamarckism was prevalent in America many years before the *Origin*:

> 'Some flossifers think thet a fakkilty's granted
> The minnit its proved to be thoroughly wanted,
> Ez, fer instance, thet rubber-trees fust begun bearin'
> Wen p'litikkle conshunces come into wearin',
> Thet the fears of a monkey, whose holt chanced to fail,
> Drawed the vertibry out to a prehensile tail.'

The year of the Manchester meeting, 1887, was the fiftieth anniversary, and we are now celebrating the Centenary, of the entry in Darwin's pocket book:

'In July opened first note-book on Transmutation of Species. Had been greatly struck from about the month of previous March on character of South American fossils, and species on Galapagos Archipelago. These facts (especially latter), origin of all my views.'

It is especially interesting to recall that these views, as Professor Newton told us in his address to D, the Biological Section, did not include Natural Selection which only came into Darwin's mind when he read Malthus, *On Population*, in October, 1838. Newton, who had read the proof-sheets of the great *Life*

[8] *Life and Letters*, 1900, vol. ii. p. 579.

[9] From a letter of August 10, 1894, printed in the *Jesus College (Oxford) Magazine*, for Lent Term, 1925; and reprinted in *Hope Reports*, vol. xvi, 1929, no. 3, p. 6. (Privately circulated to many scientific libraries.) Huxley's letter of August 18, 1894, to Lewis Campbell (*Life and Letters*, vol. ii, p. 379) refers to the same subject.

[10] The lines are quoted from the First Part, published 1845–48.

of Darwin, published later in 1887, then spoke of Wallace's independent discovery, made twenty years after Darwin's, a discovery suggested to him also by reflecting on Malthus, and of the friendship between the two great men to whom this fruitful conception had come, referring the cynic who would 'point the finger of scorn at the petty quarrels in which naturalists unfortunately at times engage' to this 'greatest of all cases, where scientific rivalry not only did not interfere with, but even strengthened, the good feeling which existed between two of the most original investigators.' And here I cannot resist the desire to quote a part of the speech made by Wallace at the most thrilling scientific gathering I have ever attended—the fiftieth anniversary of the Darwin-Wallace Essay read before the Linnean Society on July 1, 1858, only twelve days after the arrival of Wallace's letter and manuscript from the Moluccas. Wallace then said on July 1, 1908:

"The idea came to me, as it had come to Darwin, in a sudden flash of insight; it was thought out in a few hours . . . and sent off to Darwin all within one week. *I* was then (as often since) the "young man in a hurry"; *he*, the painstaking and patient student, seeking ever the full demonstration of the truth that he had discovered, rather than to achieve immediate personal fame.... If the persuasion of his friends had prevailed with him, and he had published his theory, after ten years'—fifteen years' or even eighteen years' elaboration of it *I* should have had no part in it whatever, and *he* would have been at once recognised, and should be ever recognised, as the sole and undisputed discover and patient investigator of the great law of "Natural Selection," in all its far-reaching consequences.' [11]

Amusing evidence of the difficulty with which this 'great law' was understood is afforded by a verse written by Lord Neaves and dated May, 1861:

'A deer with a neck that was longer by half
Than the rest of its family's (try not to laugh),
By stretching and stretching, became a Giraffe,
Which nobody can deny.' [12]

[11] *Darwin-Wallace Celebration of the Linnean Society of London*, 1908, pp. 6, 7.

[12] *The Origin of Species. A new song.* In *Songs and verses, social and scientific, by an old contributor to Maga. Edinburgh*, 1868 2 Ed.

Yet Wallace, referring to Lamarck's hypothesis and 'that now advanced,' had written in his Section of the Joint Essay:

'Neither did the giraffe acquire its long neck by desiring to reach the foliage of the more lofty shrubs, and constantly stretching its neck for the purpose, but because any varieties which occurred among its antitypes with a longer neck than usual *at once secured a fresh range of pasture over the same ground as their shorter-necked companions, and on the first scarcity of food were thereby enabled to outlive them.*'

There were fortunately others who did not launch such ill-aimed criticism. Thus Professor Newton, reminding the Section that the new teachings had been at once accepted by Canon Tristram[13] before the appearance of the *Origin of Species* (on November 24, 1859), expressed, with all the enthusiasm of one who was devoted to the same delightful branch of natural history, 'the hope that the study of ornithology may be said to have been lifted above its fellows.' It was indeed very fortunate that the Darwin Wallace Essay should have been read so soon after its appearance by a naturalist who looked on the species question as did Tristram - a great traveller and observer who studied indefatigably the birds he loved, as living creatures and in as many countries as he could visit.

At the last meeting of the British Association in Nottingham (1893) Canon Tristram was President of Section D and, in his address, gave an account of the observations referred to by Newton at Manchester. The historic interest of this early acceptance of Natural Selection is such that I have prepared a brief abstract of his chief conclusions:

During a visit of many months to the Algerian Sahara in 1857-58, he 'noticed the remarkable variations in different groups, according to elevation from the sea, and the difference of soil and vegetation.' On his return he read the Darwin-Wallace Essay and wrote, 'It is hardly possible, I should think, to illustrate this theory better than by the larks and chats of North Africa.' He then explained how the colours arose by selective destruction of birds which harmonized less well than others with the surface of the desert. And similarly with other larks having 'differences, not only of colour, but of structure,' chiefly 'marked in the form of the bill.' He took as instances a very long billed lark (*Galerita arenicola*), resorting exclusively to the deep, lose, sandy tracts, and a very short

[13] *Ibis*, October, 1859, pp. 429—433.

billed allied species (*G. isabellina*), haunting the hard and rocky districts. He then pointed out that there is individual variation in the bills of larks and that the shorter-billed birds would be at a disadvantage in obtaining food from sandy areas but at an advantage among the rocks where strength is required. He concluded, 'Here are only two causes enumerated which might serve to create, as it were, a new species from an old one. Yet they are perfectly natural causes, and such as I think must have occurred, and are possibly occurring still. We know so very little of the causes which in the majority of cases, make species rare or common that there may be hundreds of others at work, some even more powerful than these, which go to perpetuate and eliminate certain forms "according to natural means of selection."'

The temptation to record an amusing incident which happened at one of the meetings of Section D at Manchester, cannot be resisted. Work was proceeding smoothly under the genial guidance of Prof. Newton when, suddenly, Dr. Samuel Haughton of Dublin entered and from the back of the room announced in arresting tones that he had an important communication to make about the animals preserved from the Flood. He believed that Mrs. Noah strongly objected to her husband's intention to take the elephants on broad, fearing that their weight would cause a dangerous displacement of the Ark's metacentre. How this domestic difference was composed we had no opportunity of learning, for as the Chairman, whose expression combined sympathetic amusement with mild depreciation, was rising and about to protest, Dr. Haughton, anticipating the result, had already turned towards the door, telling us over his shoulder that he was on his way to make a fuller communication on the subject to the Anthropological Section.

After this brief description of an event, which I hope you will agree ought not to be forgotten, we must return to Organic Evolution and to one of the most important subjects debated at any time before a meeting of the British Association—the question, "Are Acquired Characters Hereditary?"—brought before the world by Prof. August Weismann, who was present at Manchester and spoke in the discussion (unfortunately not reported), introduced by Ray Lankester, in which Dr. Hubrecht, Patrick Geddes, Marcus Hartog and the present speaker, took part. Weismann's conclusion that 'Acquired Characters' are not inherited, was held by Prof. Goodrich, in his address to Section D at Edinburgh in 1921, to be 'the most important contribution to the science of evolution since the publication of Darwin's *Origin of Species*,' an opinion with which the great majority of biologists will agree, although the terms employed for the two classes, the Inherited and the Non inherited, together with the ideas underlying them, were shown by Adam Sedgwick, at Dover in 1899, Archdall Reid, and others, as well as by Goodrich himself, to be incorrect. Nevertheless it will probably be impossible to abandon the word 'acquired,' employed by Erasmus Darwin (1794), Lamarck (1809), and Prichard (1813) as well as by later authorities. Whenever environmental conditions are followed by characteristic changes, absent when these conditions are absent; or when such changes follow the use or disuse of the parts of an organism, or the education it has received, then we have before us the 'acquired' characters maintained by Weismann to be incapable of hereditary transmission. This vital conclusion, accepted, as I believe it is, by nearly all biologists, is not appreciated at it ought to be by the general public. A brief statement of a single piece of evidence may convince some who are doubtful about a conclusion with which human life is very deeply concerned.

My old friend the late A. A. Macdonell, Professor of Sanskrit at Oxford, spoke two languages, English and German, as they are spoken by native Englishmen and Germans. I asked him whether he thought it was possible for any mature person to learn a foreign language so perfectly that he would be mistaken for a native. He replied that he was sure it could not be done and that his own ability to speak the two languages as he did had been only made possible because as a small child he had been continually taken backwards and forwards between the two countries. Yet any human being transported as a baby from his own country to another and brought up there among the natives will learn to speak as they speak. All the past generations, however many, during which his ancestors spoke the language of his birthplace, will count for nothing, will not retard his acquisition of another tongue or modify it in any way.

An interesting and amusing example is provided by the futile striving of an Englishman to pronounce the Welsh double-l, generally attempted by the substitution of 'th'. And even the advice given by a Welsh clergyman to the English Bishop of his diocese

is unlikely to bring success: 'You must put the tip of your Right Reverend tongue against the roof of your Right Reverend mouth, and hiss like a goose.'

The result of education as an 'acquired' character in the Weismannian sense is of such special importance that I think it is well to quote the conclusions stated by Ray Lankester in his address to the seventy-fifth meeting of the Association at York. He then maintained that the 'power of building up appropriate cerebral mechanism in response to individual experience, or what may be called "educability," is the quality which has to its selection, survival, and further increase in volume'....' "Educability" can be transmitted; it is a congenital character. But the *results* of education can *not* be transmitted. In each generation they have to be acquired afresh.....On the other hand, the nerve-mechanisms of instinct are transmitted and owe their inferiority as compared with the results of education to the very fact that they are *not* acquired by the individual in relation to his particular needs, but have arisen by selection of congenital variation in a long series of preceding generations.'[14]

Lankester was led by these conclusions to reject altogether the theory of G. H. Lewes, G. Romanes, and others, that instincts are due to lapsed intelligence,' a theory also disproved by Lloyd Morgan's observations on young birds described by him at the Ipswich meeting in 1895.[15] Another very important subject brought forward by Lankester was the evidence, originally published by him in 1894,[16] that Lamarck's first and second laws of heredity 'are contradictory the one of the other, and therefore may be dismissed.' His statement may be briefly summarised as follows:

The first law assumes that in spite of thousands of generations during which a normal environment has 'moulded the individuals of a given species of organism, and determined as each individual developed and grew "responsive" quantities in its parts (characters); yet, as Lamarck tells us, and as we know, there is in every individual born a potentiality which has *not* been extinguished. Change the normal condition ....and (as Lamarck bids us observe), in spite of all the long-continued response to the earlier normal specific conditions, the innate congenital potentiality shows itself. The individual....shows *new* responsive quantities in those parts of its structure concerned, new or acquired characters.'

'So far, so good. What Lamarck next asks us to accept, as his "second law," seems not only to lack the support of experimental proof, but to be inconsistent with what had just preceded it. The new character which is *ex hypothesi*, as was the old character ....is, according to Lamarck, all of a sudden raised to extraordinary powers. The new or freshly acquired character is declared....to be capable of transmission by generations; that is to say, it alters the potential character of the species. It is no longer a merely responsive or reaction character, determined quantitative conditions of the environment, but becomes fixed and incorporated in the potential of the race, so as to persist when other quantitative external conditions are substituted for those which originally determined it.'

The effect of Lamarck's laws on the hereditary transmission of acquired characters would be this: 'a past of indefinite duration is powerless to control the present, while the brief history of the present can readily control the future.'

After hearing a very condensed statements of conclusions so essentially bound up with the progress of Organic Evolution, I feel sure that you will wish to be reminded of Prof. Ewing's words which followed the address at York:

'Now is the winter of our discontent made glorious summer by this Ray of Lankester.'

Returning to the unreported discussion on the inheritance of acquired characters at Manchester, I venture to bring forward certain observations opposed to a belief in Lamarckian evolution by means of inherited experience— observations which I then described and have not known to be answered. In the relationship between enemy and prey there is very commonly no opportunity for the latter to learn by experience. The wonderfully elaborate adaptations by which sedentary insects are hidden from enemies have been evolved, not by experience of enemies but by avoidance of enemies. In these examples, and they are numberless, we are driven to accept Weismann's conclusion and with him to invoke 'the all-sufficiency of Natural Selection.' When one of

[14] *Report, British Association*, 1906, pp. 26-27. The conclusions here quoted had been communicated to *Societe de Biologie* of Paris, in 1899 (Jubilee Volume) and were reprinted in *Nature*, vol. lxi, 1900, pp. 624-625.

[15] *Report, British Association*, p. 734.

[16] *Nature*, vol. li, 1894, p. 127: *Report, British Association*, 1906, pp. 29, 30.

the twig-like caterpillars, of which there are so many in this country, is detected by an insectivorous bird it can do nothing and is devoured at once. Its one defence is the astonishingly perfect resemblance to a twig of the bush or tree on which it lives. It is firmly fixed and its weight also supported by an almost invisible thread so that it cannot escape as many caterpillars do by dropping to the ground and sheltering in the grass or among dead leaves. Its one chance of survival is to gain so perfect a disguise that it will not be seen, and to gain this end the adaptive devices are most elaborate and wonderful: its twig-like shape and colours with the power of gradually adjusting these so as to resemble the bark of the bush or tree on which the parent moth laid the egg from which it came, even the power to reproduce exactly the appearance of lichen, the rigid stick-like attitude maintained during the hours of daylight. Finally there is the evidence, recently obtained by Robert Carrick,[17] that the disguise *does* protect; for examples of one of these caterpillars, resting on a branch of its food plant fixed over a wren's nest containing young, were unnoticed by the parent bird which used the same branch as a convenient perch; yet seen and at once taken when placed on a white surface below.

One of the best examples of a prophetic instinct is to be found in the larva of an African Tabanid fly (*T. biguttatus*). This maggot lives and feeds in soft mud which, during the dry season when the chrysalis stage has been reached, will be traversed in all directions by wide and deep cracks in which insectivorous animals can search for prey. But the maggot, while the mud is still soft, prepares for this danger. By tunnelling spirally up and down it makes a line of weakness which will cause a pillar to separate from the mass when the mud hardens and contracts. It then tunnels into the still soft pillar and becomes a chrysalis in the centre of its deeper end. However wide the cracks which appear in the mud, the maggot has arranged beforehand that they will not invade its cylinder. Dr. W. A. Lamborn, who made this most interesting discovery, observed that the summits of the pillars, forming circular discs of about the size of a penny, scattered here and there over the surface, were never thus traversed, but that an empty shell was protruding from the centre of each when the fly had emerged.[18] My friend the late Prof. J. M. Baldwin, the distinguished American psychologist, well remembered at many of our meetings, wrote when he heard of this discovery: 'it seems *complete* one of those rare cases of a single experience being sufficient to establish both a fact and a reason for the fact! It is beautiful.'

I would ask any believer in Lamarckian evolution, or in Hering's and Samuel Butler's theory of unconscious memory residing in the germ-cells, how it would be possible to explain these prophetic instincts, adapted not to meet but to avoid future experience, except by the operation of natural selection.

The appeal to Orthogenesis, or internal developmental force, as the motive cause of evolutionary progress has often been made generally by palaeontologists rather than by the observers of living forms. Any such belief in the potency of an internal tendency is, I think, open to the criticism made by Thiselton Dyer in his address to Section D at Bath in 1888: 'This appears to me much as if we explained the movement of a train from London to Bath by attributing to it a tendency to locomotion. Mr. Darwin lifted the whole matter out of the field of mere transcendental speculation by the theory of natural selection, a perfectly intelligible mechanism by which the result might be brought about. Science will always prefer a material *modus operandi* to anything so vague as the action of a tendency.'

It is not necessary for me to speak on the rediscovery of Mendel's great work and all that it has meant to our Biological Sections in the early decades of the present century. The recent developments, following the work of Haldane, R. A. Fisher, and others, and the vitally important relationship between Mendelism and Natural Selection were brought before us last year in Julian Huxley's illuminating address to Section D. The older belief that only large variations, or mutations as they then began to be called, were subject to Mendelian inheritance, and that small variations were not inherited, at all, disappeared when further researches proved that extremely minute differences were 'heritable in the normal Mendelian manner,'[19] and, with this, the foundation of Darwinian evolution became immensely strengthened. It is also right to remember that Bate-

[17] *Trans. Roy. Ent. Soc. Lond.*, vol. 85, part 4 (May 1936), p. 131, 3 pls.

[18] *Proc. Roy. Soc.*, B, vol. 106, 1930, p. 83, pl. v; *Proc. Ent. Soc. Lond.*, vol. v, 1930, p. 14.

son, the leader of Mendelian research in this country, always believed in Natural Selection, regarding it indeed as self evident and not very interesting. Also that Ray Lankester, as long ago as his 1906 address at York, maintained that however far Mendelism was advanced it 'would not be subversive of Mr. Darwin's generalisations, but probably tend to the more ready application of them to the explanation of many difficult cases of the structure and distribution of organisms.'

The relationship between the germinal foundation of Mendelian and Wismannian heredity was considered in a paper by L. Doncaster read before Section D at the South African meeting in 1905. He then maintained that Weismann's 'hypothesis that the material bearer of hereditary qualities is the chromatin of the nucleus' of the germ-cells had been confirmed by recent work on their maturation which 'has shown that they contain a mechanism which seems precisely adapted to bring about that segregation of characters which forms the most fundamental part of the Mendelian theory, and it seems hardly possible that the two things are unconnected.' MacBride also in his address to the same section at Newcastle in 1906, spoke of the 'great epoch making discovery of experimental embryology, *viz.*, the existence of SPECIFIC ORGAN-FORMING SUBSTANCES.' These fundamental discoveries bring to mind a conversation with Weismann when he had been finally driven to frame and elaborate this hypothesis, and was so appalled by the number and minuteness of the material bearers of hereditary qualities contained in a single germ-cell that, as he told me, he could not believe that the physicists and chemists were correct in their conclusions about the size of the atom. He admitted that diverse lines of evidence led to the same result, but even so, he believed the future would prove that physicists were mistaken and that the atom was far smaller.

It is impossible to say more than a few words about the very interesting and important discussion on 'The present state of the Theory of Natural Selection' held at the Royal Society on May 14 last year. The subject was approached from many points of view by both zoologists and botanists, and their conclusions were very welcome to Darwinians who remembered the earlier opinions expressed when Mendel's great work was rediscovered. I think, however, that Prof. D. M. S. Watson, in the opening address, was inclined to underestimate the value of the existing evidence for a 'selective death rate,' although everyone will agree that 'any new evidence... or indeed any suggestion of cases which might be capable of investigation,' would be most desirable.

I may briefly mention a few experiments brought before Section D at the Bristol meeting in 1898 beginning with the work of Weldon and Thompson on the Common Shore Crab, showing that the effect of china clay and other impurities in the sea at Plymouth was selective and promoted changes of shape which ensured that the water flowing over the respiratory surface was more efficiently filtered.

Then, on the subject of chance, the heroic help rendered by Mrs. Weldon, who four times recorded the result of 4,096 throws of dice, showing that the faces with more than three points were on the average, uppermost slightly more often than was to be expected. It comes back to me very clearly because of the interesting explanation that the points on dice are marked by little holes scooped out of the faces, and 3 are somewhat lighter, more of the ivory having been removed; also because of Francis Galton's delight and his humorously expressed wonder whether the facts had been realised by those who had an interest other than scientific in the throwing of dice.

Experimental evidence was also submitted by Miss Cora B. Sanders (Mrs. C. B. S. Hodson) and myself, proving that when the rough, angular pupa of the small tortoiseshell butterfly 'is suspended from a surface against which it stands out conspicuously, it is in far greater danger than when it is fixed to one upon which it is concealed.

To the observer of living creatures, however, the most convincing evidence is provided by animals themselves. When a wild bird is seen to capture some conspicuous butterfly or moth and then immediately to reject it the association between inedibility and a warning colour is more convincingly suggested than when insects are offered to animals in confinement, although such experiments are of great value and often provide the only available evidence. There are, however, instances in which abundant data for statistical investigation are furnished by the wild animals themselves. Thus the long-eared bat has the conve-

[1a] *Report, British Association,* 1931, p. 77 and references quoted.

nient habit of eating moths—its regular food—while it hangs suspended from a surface to which it returns after each capture; and as the wings are rejected, these may be collected in large numbers, yielding valuable information on the significance of concealing and warning patterns.

In the attempt to determine the motive cause of organic evolution, the work of the naturalist, the student of living nature, is essential. His task is to do what Lyell did for geology by directing attention to the forces now in operation and seeking with their help to interpret the past, and in this work it is especially valuable to study adaptations which have been developed in recent times and can, in certain instances, be proved to undergo changes even now. Thus the interesting observations of H. Lyster Jameson showed that a pale local race of the common mouse had been formed, although incompletely, in from 100 to 125 years by the selective attacks of owls and hawks on sandhills near Dublin.[20] I therefore believe that the colours of animals provide one of the most fruitful fields in which to pursue these investigations, and I regret that this work has been recently attacked by an American zoologist who, referring to the recent revival of natural selection, continues—'if the doctrine can emerge minus its sexual selection, its warning colors, its mimicry and its signal colors, the reaction over the end of the century will have been a distinct advantage.'[21] It is of course impossible to discuss, on the present occasion, this confident attempt to depreciate the value of work associated with the names of Bates, Wallace, Trimen and Fritz Müller. I will only point out that their conclusions on warning colours and mimicry have been immensely strengthened and confirmed by the later observations of Guy Marshall, W. A. Lamborn, St. Aubyn Rogers, Hale Carpenter, V. G. L. van Someren and others in Africa; by the experiments conducted by some of these naturalists, and also by H. B. Cott and R. Carrick, and in the United States by Morton Jones.

It is interesting to remember that a paper by two American entomologists[22] was among the first to accept and support by fresh observations the conclusions brought forward by H. W. Bates in his great memoir on the mimetic butterflies of the Amazon Valley,[23] and that one of the authors treated the same subject more completely in a later paper[24] much appreciated by Darwin.[25]

It is also important to remember that the abovementioned conclusions have been reached by the study of marine animals no less than terrestrial, as was shown by Herdman in his address to Section D at Glasgow in 1901, and by his experiments communicated to the same Section at Ipswich in 1895; also that Garstang, with his very long and intimate experience of marine life, adopts the same interpretation of colour and form with the associated attitudes and movements.

If time permitted it would be possible to speak of numerous papers on mimicry and the related subjects which have been brought before our meetings. It is impossible to attempt this now, but many will feel with me that the name of the late Dr. F. A. Dixey should not be forgotten—one who attended so regularly, so often read papers at our meetings, presided over Section D at Bournemouth in 1919, lectured at Leicester in 1907, always giving the results yielded by the study of his favourite insects, and their interpretation by the theory of natural selection; also one who delighted in the social gatherings of his Section, where his rendering of *Widdicombe Fair* will be long remembered.

In my concluding remarks I am anxious to refer to a very interesting and encouraging subject—the feeling for animals and the care for their welfare to-day, as contrasted with the treatment they received a hundred years ago and even in the youth of many among us. Only last autumn *The Times* of October 12, reported that 1,000 swallows had arrived at Venice 'sent there by bird-lovers from Vienna and Munich in order to save them from the effects of the cold weather. Soon after their arrival they were set free and flew south along the Adriatic coast.' And a little earlier the writer of the amusing 'Fourth Leader' referred to a meeting of the Society for the Preservation of the Fauna of the Empire at which the care of the opossum was discussed, comparing this with

[20] *Journ. Linn. Soc.* (Zool). vol. 26, 1898, p. 465, pl. 30.

[21] *Evolution.* A. Franklin Shull. (New York, 1936).

[22] Walsh and Riley: *The American Entomologist*, St. Louis, Mo., 1859, vol. i, p. 189.

[23] *Trans. Linn. Soc. Lond.*, vol xxiii, 1862, p. 495.

[24] Riley: *Third Annual Report on the Noxious ... Insects of ... Missouri*, 1871, p. 142.

[25] *Charles Darwin and the Theory of Natural Selection* (Poulton, 1896), p. 202.

the report of happenings a hundred years earlier when was a 'humorous debate' at the Zoological Society 'about puffing cigar-smoke into the cages of the monkeys,' to their evident discomfort. The writer, yielding too far, we hope, to the depression of the present day, concludes: 'The world, it may be, is "man-sick" and yearning to be rid of a bad mistake. But the creature cannot be wholly vile when instead of torturing monkeys it takes thought for the opossum.' It would not be right to quote from a century old report without speaking of all that is done and has been done during many years for the care and health of animals by the great London Society, and in doing this, for the education and happiness of our people. But the change of which I have spoken is most deeply impressed on those who remember, as many of us do, the misdirected hours in youth when birds were shot in our gardens and brick traps made to catch them. I feel sure that those who did these things are not essentially different from their children and grandchildren who have grown up in a kinder atmosphere. I must not occupy more time on a subject which to some may seem inappropriate, but it is bound up with education in its true sense—a leading out and if, as Ray Lankester said at York, and we are all coming to believe, the hidden powers within *are* inherited while the results of their development are *not*, then there is no easing of the burden with the passage of time, but each generation afresh must bear the heavy responsibility of conducting this development in the best way so that its successor may be able to meet the changing and, at this time, the increasing needs. The relationship between the powers within and their development was suggested in arresting words by the late Prof. Scott Holland: 'To say that a man cannot be made good by Act of Parliament is such an obvious truth that people forget what an outrageous lie it is!'

Thoughts on the development of these hidden powers by the educating influence of social environment, suggest the greatest of the problems by which we are faced—the end of international war. Michael Foster, in his Address at Dover in 1899, after speaking of progress in the material of warfare was led to believe that, 'happily, the very greatness of the modern power of destruction is already becoming a bar to its use, and bids fair—may we hope before long?—wholly to put an end to it; in the words of Tacitus, though in another sense, the very preparations for war, through the characters which science gives them, make for peace.' And in his concluding pages he expressed the hope that the brotherly meeting between the English and French Associations at Dover and Boulogne might be looked upon as a sign that science, by nobler means than the development of armament, was steadily working towards the same great end. And, in a time of still greater need and perplexity, may we not, in the same hopeful spirit, look upon the recent visit by which members of the French Association have honoured us, and feel strengthened in the belief that the great end will be reached.

There are, I know, very many people who look upon the Great War with later wars and rumours of wars as the close of Michael Moster's dream. The words in which Sir Arthur Schuster concluded his address at Manchester in 1915, and Sir Edward Thorpe at Edinburgh in 1921, indicate, I hope, that the British Association does not thus despair and in this belief I bring before you a passage from the far earlier address which Sir Richard Owen delivered to the Twenty-eighth Meeting at Leeds in 1858 a passage which makes a special appeal at a time when the British and American Associations are confidently hoping to strengthen still further the bonds of sympathy and mutual appreciation by which they have been happily united for so many years.

Referring to the transatlantic telegraph Sir Richard said:

'We may confidently hope that this and other applications of pure science will tend to abolish wars over the whole earth; so that men may come to look back upon the trial of battle between misunderstanding nations as a sign of a past state of comparative barbarism; just as we look back from our present phase of civilisation in England upon the old border warfare.'

Confident words inspired by the forging of a new link between the two great English-speaking nations. Nearly eighty years have passed since they were spoken, but with all the terrible disappointments there has been great progress, and a time will surely come, and may it come quickly, a time which shall prove that the visions of the young and the dreams of the old were prophetic of a glorious reality.

Notes and News

Indian Students and Foreign Scholarships

Perhaps no country stands in greater need of foreign scholarships to enable her young men to receive adequate training in different branches of science and industry than India. Yet it is the misfortune of the latter that she does not enjoy the benefit of such scholarships in any appreciable measure. The apathetic attitude of her own Government to questions of this nature is well known, and has been commented upon times without number both in print and speech. The number of awards made to Indians is extremely inadequate and out of all proportion with the requirements of the country. In the *Modern Review*, September 1937, pp. 244-45, " Scientificus " raises the question and deals with the subject at some length. He especially mentions in this connection (1) the Rockefeller Foundation, (2) the Carnegie Corporation of New York, (3) the 1851 Exhibition Scholarship Trust, (4) the Deutsche Akademie of Munich, and (5) the Tata Charities. All these are bodies which award scholarships to deserving students and professors mostly on an international basis. But the very scant regard these bodies (except, of course, the Deutsche Akademie) have so far paid to the claims of Indian students cannot be suffered to pass unnoticed and calls for some comment. Let us first take the case of the Rockefeller Foundation which professes to be international in principle. But in actual practice, we find that their activities are mostly limited to those countries which cannot be said to be really in need of its aid. India has been sadly in want, and has been crying herself hoarse for years for outside help without much response. " No rational explanation," writes Scientificus, "can be found for the strange attitude of the Rockefeller Foundation refusing all assistance to India except in medical affairs. The impression is that their charity programme is not after all so disinterested as it is claimed to be. Their policy appears to be guided by deep political, economic, and commercial reasons of which the public in general are quite ignorant". About Carnegie Charities, the same story may be repeated; though recently one or two scholarships have been given to Indians, India has not profited in any appreciable manner.

The interesting story of the 1851 Exhibition Scholarships has already been told in these columns (Sc. & Cult. vol I. pp 480-82) and is perhaps familiar to the reader of this Journal. It is another story to prove how far injustice towards India can go. In view of the munificent contribution India made towards the establishment of the funds, " she can justly claim one-third of the scholarships given by the Governors of the 1851 Funds, and if she were in the position of a Colony like Canada or Australia and not a dependency, she would have seen that her claims were enforced." But what about the Tata Trust which is Indian in character but which believes more in international charities than in charities at home. It is really strange that it should spend 95 per cent. of the charities for giving scholarships to foreign countries. " Charities must begin at home and there can be no justification for export of money earned in India for purposes of charities to foreign countries when the needs of India are colossal. . It is desirable that the Indian public should take up the agitation and bring sufficient pressure upon the present Trustees of the different Tata charities so that they may be forced to adopt a more patriotic policy. If the charities are all ear marked for Indian scholars and Indian research institutions, India would be helped to the path of progress. Let us hope that this will be done." In many of the provinces, the Congress has taken up the reins of Government. We expect that their governments will find it possible to send up a large number of scholars to foreign countries on a properly co-ordinated plan. Their choice and training should be based on the needs of the country and when they return they should be provided with suitable opportunities for displaying their abilities and talents in the service of the country.

All-India Educational Conference

This year the All India Educational Conference will be held in Calcutta. Last year it was held at Gwalior (SCIENCE AND CULTURE 2, 260, 1936). It

is an important and useful annual event in the Indian educational world and deserves every encouragement and support from the public. We are, therefore, glad to give publicity to the following appeal issued by the local Reception Committee of which Mr. Sanat Kumar Roy Choudhury, Mayor of Calcutta, is the chairman and Mr. K. P. Chattopadhyay the General Secretary.

The Thirteenth Session of the All-India Educational Conference will be held in Calcutta this year during Christmas Holidays. This Conference is held under the auspices of the All-India Federation of Educational Association. The different Teachers' Associations and Educational organizations in India are affiliated to the Federation, which, in its turn, is affiliated to the World Federation of Educational Associations. For the last twelve years the Conference has been holding its annual session in different parts of India under the presidency of distinguished Indian educationists.

Last year the Conference was held in Gwalior, and the State bore all the expenses incurred in connection therewith. The amount of expenditure for such Conferences comes to the neighbourhood of Rs 8,000/-, towards which, we are glad to announce, the Calcutta Corporation has made a grant of Rs 1,500/- and the Calcutta University has sanctioned a sum of Rs 500/-. We have also requested the Bengal Government to sanction an adequate grant. The Membership of the Reception Committee and the delegation fees may bring in a sum of Rs 2,00/-. Taking all these details into our careful consideration, we have come to the conclusion that a sum of Rs 5,000/- will have to be raised from the generous public in the shape of donations.

We earnestly hope that the public of Bengal will give this matter their kind and careful consideration, and help the Reception Committee with adequate financial assistance to hold successfully the session in Calcutta this year in a way befitting the fair name of Bengal and the hospitality of the Bengali people.

We also appeal to all educational institutions in Bengal (Primary and Secondary Schools as well as Colleges) to associate themselves with this Conference by contributing a suitable amount as donation and also by sending teachers as delegates.

Indian Science Abstracts

We have already drawn the attention of the reader to the *Indian Science Abstracts* published by the National Institute of Sciences of India under the general editorship of Dr Baini Prasad, Director of the Zoological Survey of India (See Sc. & Cul. vol II, pp. 97-98). The publication in intended to include abstracts of all scientific papers published in India, as also of papers published abroad on work done in India or based on Indian material. Though two parts of it have already come out, to deal with papers published during 1935, it has not been found possible to cover all the papers. It has therefore been decided to bring out a further part so that the publication may be complete for 1935. Those authors whose publications have not already been incorporated are therefore requested to send in the abstracts of their respective papers to the Editor, 1, Park Street, Calcutta, at an early date in order to enable him to publish these in the next part.

Indian Science Congress Jubilee meeting

The following two additional discussions have been arranged for the Section of Anthropology, (1) Opportunities for Archaeological excavations in India; (2) The Importance of Anthropological studies for India.

In our August issue we announced that a discussion on "Animals and their diseases in relation to man" had been arranged for the Sections of Medical Research and Physiology. The General Secretary of the Indian Science Congress now informs us that through an error the name of the Section of Veterinary Research was omitted. It is understood that Sir Frederick Hobday will be taking part in this discussion.

The following scientists have recently accepted the invitation to attend the meeting:—Prof. C. G. Jung, Professor of Psychology, University of Zurich; Professor Sir Frederick Hobday, lately Principal of the Royal Veterinary College, London; Prof. G. W. O. Howe, James Watt Professor of Electrical Engineering, University of Glasgow; while Prof. M. Caullery, Wimereux Zoological Station, France, hopes to be able to come.

S. M. Sulaiman

On the eve of his departure from Allahabad to

take up his appointment at the Federal Court, high tributes were paid to Sir Shah Muhammad Sulaiman as a man, as a lawyer and as a scientist by the eminent citizens of Allahabad. Our readers have already had the occasion to read two articles from his pen of Einstein's general theory of relativity in which he gave a critical review of the astronomical observations on which the experimental confirmations of Einstein's theory are supposed to rest. As is well known Sir S. M. Sulaiman has his own views on certain fundamental problems of physics which he has developed in a number of scientific papers read before the National Academy of Sciences. The keynote of his gravitational theories is that the forces are not propagated instantaneously, but with the velocity of light; that the force acting on a mass point is not that due to the instantaneous position of the source, but due to the position which the source occupied at a previous epoch which preceded the time of observation by the time of propagation.

In this connection we quote below some remarks of Prof. M. N. Saha from *New Thought* which our readers will find interesting.

" There is, I must admit, a slight touch of Aristotelianism in all these works, inasmuch as assumptions have been made of particles and laws which have yet to respond to the physicists' identification parade. But this seems to be a feature of the times. The experimentalist and the observing astronomers have gone ahead of the theoretical man with their explorations and have discovered new facts and phenomena which do not fit in with the established order. Such are the cosmic rays, the red shift of nebular lines, the nuclear reactions, etc. The theoretical physicist, unable to keep pace, falls back on speculations. Eddington counts the number of particles in the universe, Dirac predicts antiparticles, Milne gets all the equations of relativity dynamics and quantum physics out of his cosmological principles which, in his hand, act like a magician's hat. Dr Sulaiman has also invented radions, gravitons, and light particles executing screw motion. What are the values of these speculations? The answer is " Wait and see." *In* spite of spectacular advances in science and technology, those who are in the know of such attempts all feel that we are after all no better than Plato's chained men in a cave, unable to form any picture of the universe except from the shadows passing before us. If a keener mind sees in these shadows more than the ordinary mind, we can admire the ingenuity of such attempts, but surely cannot accept them until the predictions come within the range of reality. But at the same time, we cannot dismiss them as being merely speculative, for what intellectual progress has been possible without speculation?

Latest Figures of World Population

The Statistical year-Book of the League of Nations, 1936-37, has just been published. It is a well-known annual publication and contains as usual very useful and complete summary of the statistics of the chief demographical, social, economic and financial phenomena. According to this book the population of the world at the end of 1935 was estimated to be about 2,095,490,000. The increase during that year was rather less than 1 per cent. The number of persons per sqr. kilometre (1 kilometre=⅝ of a mile nearly) was roughly 5 in Africa, 6.5 in America, 41 in Asia (excluding the U. S. S. R.), 72 in Europe (excluding the U. S. S.R.) 8 in the U. S. S. R, and 1 in Oceania . As compared with 1935, there was a general increase in births in 1936 and a small decrease in deaths.

Radium E

Bombarding bismuth with deuterons Dr. J. J. Livingood has obtained for the first time radium E—one of the intermediate products of the slow degradation of radium leading to end product inactive lead. These experiments have been carried in a laboratory of the University of California with the help of cyclotron of 25 tons.

Plant Hormones

Dr. P. W. Zimmermann of Boyce Thompson Institute for Plant Research (N. Y.) has obtained a prize of 1000 dollars from the American Association for the Advancement of Science for his discovery of substances favouring growth of plants analogous to hormones in the animal kingdom. The most active are naphthalene acetic acid, four compounds of indole and phenylacetic acid.

Why some Potatoes colour on boiling

Sometimes it is observed that potatoes on boiling takes a blackish blue colouration. This would be

due to a deficiency of potassium in the soil which will lead to the formation of amino-acids which on oxidation give rise to the pigments. This is the theory of Prof. Tollingham of the University of Wisconsin.

Kotla Firoz Shah

How in course of a hunting expedition Emperor Firoz Shah Tughlak noticed the famous Asokan Monolith now standing in Kotla Firoz Shah, Delhi, and how having determined to remove it to his capital, he devised ingenious plans and carried out the operations under his supervision, is described in a *Memoir* on Kotla Firoz Shah, just published by the Archæological Survey of India. The description is taken from Sirat-i-Firozshahi, a Persian manuscript 300 years old now in the Oriental Library at Patna. It appears that the pillar was originally at the village Topra in the Ambala District from where it was removed to its present site. The removal was effected by means of ropes and pulleys. Packed in reeds and hides, and loaded on a ten-wheeled cart, the pillar was transferred to a boat on the Jumna and conveyed to Delhi where it was unloaded and then raised to the site where the present building was gradually constructed.

The protected monument Kotla Firoz Shah has recently been put in order by the Archæological Department, and with its spacious and well kept grounds adds considerably to the amenities of Delhi.

Medical Use of Radio-Sodium

In the United States two patients suffering from Leucocythemia have recently been treated by injections of radio-sodium. This appears to be the first instance of use of artificial radioactive substances. The radio-sodium has been obtained by bombardment of the chloride by deuterons projected by the cyclotron constructed by Prof. E. O. Lawrence of the University of California. The activity of this compound disappears after some hours and hence its employment is less dangerous than radium.

Iodine preferable in Aqueous Solution

According to the recent, comparative experiments made in the hospital of Boston, iodine constitutes the best antiseptic for treating cuts and wounds. Used in the form of a tincture with 7% or 3.5% it gives rise to certain irritations which are further aggravated by alcohol. It is therefore preferable to use an aqueous solution with 1% or even 0.5%.

Announcements

Dr A. K. Das, D.Sc., has been appointed Deputy Director of the Solar Observatory at Kodaikanal *vice* Dr A. L. Narayana appointed Director.

Mr L. S. Mathur, M.Sc., has been appointed Assistant Meteorologist in the Upper Air Observatory at Agra.

How long will the World's Power Resources last?

The rapid rate at which the coal and oil resources are being used makes it inevitable that the total supply of these two raw materials will be used up in the course of a few decades. Water power and wood, though inferior to coal and oil owing to their smaller fuel equivalents, are superior in the sense that these are practically inexhaustible. In the economically advanced countries specially in Europe the most accessible waterfalls have already been developed, though in India, water power has barely been touched.

Recent estimates of American statisticians (Garfias and Whetsel) give oil production a life of only about 20 years more.

The following table gives the life of world's coal supply under various circumstances

Country.	Ascertained and probable supplies.*	Coal production yearly.†	With stable production.	With yearly increase of 0·5 p.c.	With yearly increase of 2·0 p[illegible]
	——Million metric tons.——		Years.	Years.	Ye[illegible]
World	4,600,000	1,233·5	3,730	595	21[illegible]
U.S.A.	1,975,000	535·8	3,686	593	21[illegible]
U.S.S R.	1,075,000	30·3	35,478	1,037	33[illegible]
Great Britain	200,000	230·3	868	329	14[illegible]
Germany	289,000	148·1	1,951	470	18[illegible]
Poland	138,000	37·8	3,651	590	21[illegible]
Canada	286,000	11·3	25,310	969	3[illegible]
China	220,000	16·5	13,330	842	28[illegible]

* At depth of up to 2,000 m. † Average 1925-1936

SCIENCE &

Science in Industry

Chemical Industry in U. S. A.

According to a recent note in the *Chemical Age* surveying the chemical industries in the U. S. A., this country continues to hold its position as the world's largest producer and consumer of chemicals. The industry enjoys a favourable position with substantial domestic sources of supply of so many of its basic raw materials, a huge domestic market and an extensive export outlet for the products. It continues to expand as steady progress is made in the development of new products and in the improvement of manufacturing methods.

The case of dyestuff industry is typical. In 1914 the annual production was only 4,500,000 lb. and the manufacture was practically a German monopoly. Since then sheltered behind a high tariff wall the industry has now developed enormously and in 1935 produced 101,817,000 lb. supplying about 90 to 95% of domestic requirements and even exporting considerable quantities of low priced elementary dyes. At present U. S. A. occupies the second place in the world dye trade for it now supplies 20 to 25% of world production against the German share of 35% and the contribution of the United Kingdom, the third largest producer of about 10%.

Alkalis are in increasing demand particularly from the glass, textile, rayon, and chemical processing trades. The sales of soda ash and caustic soda in 1935 amounted respectively to 1,925,000 tons and 716,000 tons. It is estimated that the consumption of both soda ash and caustic soda was 10% higher than that in 1935 which was already 9% higher than the previous record established in 1929.

Import of Chemicals and Allied Materials to India

The import of chemicals during the year April 1936 to March 1937 declined by Rs. 40 lakhs and that of coal tar dyes by Rs. 43 lakhs.

Paints and Varnishes

Though the total volume of import remained practically stationary, the value decreased slightly from Rs. 80.5 lakhs in 1935-36 to Rs. 76.5 in 1936-37. The following table shows the shares of trade of the principal countries and their gain or loss in trade.

Country	Rs. (in lakhs)	
U. K. ..	47·75	(2·35)
Japan ..	9·4	(— ·9)
Germany ..	7·7	(—1·5)
U. S. A. ..	4	(+ ·75)
Other countries	8·25	(+ ·05)

Soap

With the development of Indian soap industry, import from foreign countries is steadily diminishing. Import of household and laundry soap declined from Rs. 2·9 to Rs. 2·1 lakhs; while that of toilet soap from Rs. 29·75 to Rs. 23·3 lakhs. The import from the United Kingdom which secures the largest amount of this trade fell from Rs. 27·5 to Rs. 20·3 lakhs, and from other countries from Rs. 6·8 to Rs. 6·5 lakhs.

Chemicals

The total imports of chemicals declined from Rs. 312 to 272 lakhs. The decline is spread over all the separate commodities except disinfectants, magnesium compounds and sulphur. Following table gives the figures for some of the principal commodities.

	1935-36 Rs. (lakhs)	1936-37 Rs. (lakhs)
Acids	12	9·1
Ammonia and salts thereof	10·9	10·9
Bleaching powder ..	11·9	9·1
Calcium Carbide ..	7·1	6·9
Copper Sulphate ..	4·4	3·3
Disinfectants	6·1	6·8
Glycerine	4·3	·8
Magnesium compounds ..	3·8	4·3
Potassium Chlorate ..	9·8	6·1
Sodium bicarbonate ..	7·8	5·9
Borax	3·1	2·6
Sodium carbonate ..	61·9	50·9
Caustic soda	41·3	36·6
Sulphur (brimstone) ..	20·5	21·9
Zinc compounds ..	9·4	8·6

SCIENCE IN INDUSTRY

Drugs and Medicine

In this group there was a slight decline from Rs. 211 lakhs to 207 lakhs. In patent and proprietory medicines the imports rose from Rs. 64·2 to Rs. ·68 lakhs, the share of Great Britain rising from Rs. 26 to Rs. 29·5 lakhs, that of Germany from Rs. 16 to Rs. 18 lakhs.

Coal Tar Dyes

There was a decline of about 15% in the aggregate value of dyes obtained from coal tar of this import trade, from Rs. 303·33 to Rs. 261 lakhs. Imports from Germany fell from Rs. 201 to Rs. 179 lakhs; from U. K. Rs. 41·5 to Rs. 36·5 lakhs; from Switzerland Rs. 20 to 15·5 lakhs; from Japan Rs. 12·3 to Rs. 10·7 lakhs; from U. K. A. Rs. 14·25 to Rs. 7·75 lakhs.

Stainless Steel

Prof. C. G. Fink, Head of the Dept. of Electro-chemistry, Columbia University, N. Y. has contributed an interesting article on "Chromium" in a recent issue of the *Scientific Monthly* in the course of which he says that though the metal chromium was discovered by a French chemist, Vauquelin, in 1797, it was only about 30 years ago when the electric furnace came into use that the problem of making the metal chromium or its alloys was commercially solved.

Addition of chromium to steel makes it harder and more resistant to corrosion. We all know that iron, which is by far the most important and useful metal in modern civilized world, has the unfortunate property of rusting when exposed to air specially to the highly polluted atmosphere of our cities and industrial regions. It has been estimated that the total waste through rusting amounts to more than Rs. 1000 crores per year.

For a long time the problem of preventing this waste has been investigated in the chief metallurgical laboratories of the world, and we can safely say that the most important result of these researches till now has been the production of stainless steel.

Tis variety of chrome steel is often called 18/8 because it contains 18% chromium, 8% nickel and the rest mainly iron, and forms more than half of all the chrome steels produced to-day.

Stainless steel is easily workable– can be drawn, spun, machined, and welded. This metal is of parti-cular interest to architects, as the most complicated architectural designs are faithfully carried out. The metal has an attractive permanent lustre and all maintenance expense, such as for painting ordinary steel, which runs into thousands of dollars, is entirely eliminated. It is being largely used for: store and window fronts, massive entrance doors, interior arch trim, ceiling and corridor trim, lighting fixtures, staircases, guard rails, door plates, window fittings etc. More than 100,000 sq. ft. of polished stainless steel trim cover the exterior of the Empire State Building in America.

World Power Supply

It is recognized on all hands that adequate supply of power lies at the bottom of the industrial and economic prosperity of a country. The political and economic development which the world has experienced in recent years is inducing many nations to be independent of foreign resources in the matter of power supply as far as practicable. Though the possibility of another world war is an important consideration in this respect, purely economic motives have also changed ideas in many countries in regard to power, in so far as efforts are being made in general to exploit national power resources and to make these available. However since all countries do not possess sufficient coal or or oil resources, attempts are being made to use and develop other resources specially those which are inexhaustible such as water, wood, wind, or even the tides and sun's rays.

to 1935.

Coal-Tar and Coal-Tar Products

Coal-tar forms the subject of our this month's article for "Science in Industry" section. Coal-tar distillation is one of the most important chemical industries of the world to-day and ranks in importance with those of caustic soda, sulphuric acid, and industrial alcohol. In India a large amount of coal-tar is either exported, burnt or allowed to run to waste. The article gives a preliminary survey of the technical and scientific side of the subject. The author Mr Asoke Bose is in a position to write authoritatively on the subject as he had the occasion to carry out original investigations in this line while in Germany some time back.

Industry of Coal-tar and Coal-tar Products

Asoke Bose

The subject of low-temperature carbonisation seems to have of late attracted a good deal of attention of scientists and industrialists in this country, interest being primarily centred on the production of soft-coke for domestic purposes from the non coking coals. More recently the problem of recovery and rational utilisation of the tar formed in the process of low-temperature carbonisation of coal and manufacture of motor fuel by fractional distillation of this tar have provided added stimulus to research in this line. The investigations of Dr. H. K. Sen[1] and his collaborators on the subject with reference to Indian coal have brought forth valuable materials as to the possibilities of this industry in our country. This, however, is merely one aspect of the industry based on the process of destructive distillation of coal. But there are others which should likewise commend themselves to serious consideration, one of these being the industry of high-temperature tar or simply called coal-tar, which constitutes the basic raw material for the manufacture of synthetic dyes, pharmaceutical products, perfumes, antiseptics, and other coal-tar products.

The process of destructive distillation of organic substances (that is to say, of heating them beyond the point of decomposition without access of air) is carried out for several industrial purposes. The principal object may be either the dry residue or the gases evolved, or else the condensed distillate. The last-named nearly always separates into two distillation, holding in solution a portion of the distillate; the other is formed by the condensed products insoluble in water, appearing in the form of a more or less viscid, dark-coloured oil, in some cases lighter, in others heavier, than the watery distillate, and generally known by the name of tar.

While it may be broadly said that the combustible portion of all carbonaceous residues, so far as the chemical reactions throw light upon it, does not present any great diversity and the same may be said of the permanent gases formed in destructive distillation, the watery distillates differ much according to the nature of the raw material. In the case of wood, which contains very little nitrogen, these products are of an acid nature, acetic acid being the most important, next to which come methyl alcohol and acetone. The products originating from fossil vegetable substances, such as peat and brown coal formed during comparatively recent geological periods behave in this respect similarly to wood. The acid reaction of the distillate is frequently quoted as a criterion for distinguishing brown coal from real coal. Real coal, on the other hand, due to the fact of its containing a certain amount of nitrogen, invariably yields a watery distillate whose reaction is strongly alkaline, owing to the presence of ammonia, and to some extent, of volatile organic bases. The bulk of ammonia and its salts are derived from this source, *viz.*, gas liquor, *i.e.* the ammoniacal liquor of gas-works and coke plants, which is obtained not merely by cooling, but also by washing of the gas in the scrubbers.

A similar difference exists in the oily distillates, the tars. The quantity and to a much greater extent the quality of the tar, are influenced by the nature of the raw material and by the temperature at which the decomposition of the coal is effected. It may be said generally, that the tar from peat, brown coal, and bituminous shale consists principally of hydro-carbons of the fatty (aliphatic) series, wood-tar of phenols and their derivatives, and coal-tar, on the other hand, principally of aromatic hydro-carbons. But along with the principal constituents there is always a large number of other compounds present. Coming to the coal itself we find that the higher the percentage of oxygen in the raw coal, the more tar and ammonia are formed and the more hygroscopic is the coal; on the other hand, the yield of coke and gas is less with a rise in the percentage of oxygen.

Coal carbonised at a comparatively low temperature, that is between 400° and 600°C. furnishes a tar known by the name of primary or low-temperature tar, which differs basically in composition from that which is obtained on submitting coal to a high

temperature carbonisation, that is between 1,000° and 1,200°C. In the former case mostly such hydrocarbons are formed as belong to the paraffin series, having the general formula C_nH_{2n+2} along with olefines, C_nH_{2n}. These hydrocarbons cannot on account of their chemical nature constitute the starting material for the manufacture of synthetic colours and other coal tar products for which purposes the hydrocarbons of the aromatic series are employed, but they are useful as motor fuel. They are always accompanied by oxygenized derivatives of the benzene series ((phenol), but of these the more complicated ones predominate, in some of which the methyl group (CH_3) occurs in the benzene nucleus, in others it replaces the hydrogen of the hydroxyl; *e.g.* cresol $C_6H_4(CH_3)$ (OH), guaiacol $C_6H_4(OH)$ (OCH_3), etc. If, on the other hand, coal has been decomposed at a very high temperature (between 1,000° and 1,200°), the molecules are grouped quite differently. Whilst the olefines and members of the acetylene series still occur more or less, the hydrocarbons of the paraffin series disappear almost entirely, and from these are formed on the one hand compounds much richer in carbon, on the other more highly hydrgenized bodies. The latter always occur in the gaseous state; hence the gas thus produced contains methane or marsh gas, CH_4, and free hydrogen as principal constituents, and is very much increased in quantity. Another portion contributes to the formation of compounds richer in carbon, belonging to the aromatic series, all of which are derived from benzene, C_6H_6. The action of heat effects at the same time further molecular condensations, usually with separation of hydrogen by which process compounds of higher molecular weights are formed such as naphthalene, anthracene, phenanthrene, chrysene, etc. The oxygen which is never absent must also contribute towards the formation of phenols; but here phenol proper or carbolic acid, $C_6H_5(OH)$, predominates, whilst cresol and the other homologues are diminished in quantity, and the dioxybenzenes, as well as the methylated derivatives disappear altogether. This tar is also formed by the pyrogenetic decomposition of the low-temperature tar, for example, by subjecting the latter to a bright red heat, and the mechanism of its formation in the gas-works and coke-ovens where coal is subjected to destructive distillation at very high temperatures is explained in terms of secondary decomposition of the primary tar which is believed to be originally formed in the process.

Another important factor which determines the properties and composition of the tar is the shape of the retorts used, which causes the vapours to have more or less action on the hot material of the retort. Where the volatile products are carried away from the hottest place through a narrow pipe, much less heavy and more light tar oils are obtained and the coke is more compact and harder.

The amount of tar obtained from a ton of coal varies approximately between 15 and 22 gallons (7 –10 per cent.) in the case of low-temperature carbonisation and between 3 and 9 gallons (1.4—4 per cent.) in the case of high-temperature carbonisation.

As to the equality and quantity of the chief products of carbonisation, *viz.*, coke and gas, obtained by low and high-temperature carbonisations respectively, the following observations of a general nature may be made: the amount of coke produced from every ton of coal in the case of low temperature carbonisation is about 15 cwts. as against 14 cwts. obtained by the high-temperature process. The former, called soft coke, is generally black in colour and contains about 5—8 per cent volatile matter left in it, so that it may be kindled readily in an open fire grate, and burns without smoke. It is, however, quite unfit for use for metallurgical purposes for which the hard-coke obtained by the high-temperature carbonisation alone is employed.

In comparison with that of the low temperature carbonisation the yield of gas in the case of the high-temperature carbonisation is approximately double that of the former, that is about 10,000 - 13,000 cubic feet, but is much inferior to the former in respect of its lighting power and heating value. The gas-works, however, try above everything else to get as much of gas as possible out of the coal, and therefore distil at the highest possible temperature (1,000 -1,200°). The coke obtained thereby is more or less of the quality as that obtained from coke ovens, that is to say, hard.

It would appear from what has been said above that the high-temperature tar (that is, coal-tar) is obtained as a by-product in gas-works and coke-ovens, where in both cases the destructive distillation or carbonisation is carried out at high temperatures. Coal-tar is a black, more or less viscid fluid of peculiar

1. *Proceedings* of the Institution of chemists (India), June 1934, part II.

smell and of a specific gravity varying from 1.1 to 1.28. It is an exceedingly complex mixture of an enormous number of chemical compounds, about the exact constitution of a large number of which nothing definite is known up to this day. Those which have so far been identified may be divided into hydrocarbons, of which the most important are benzene (benzol) and its homologues, toluene and xylenes, naphthalene, and anthracene; phenolic compounds of which the most important are phenol, commonly called, carbolic acid, and its homologues, cresols, and xylenols. A small proportioin of basic substances containing nitrogen, such as pyridine, and of others containing sulphur, like carbon disulphide, thiophenes, etc., is also present. Coke-tars do not materially differ from gas-tars. On the whole they yield less benzol and phenols, but rather more anthracene, and show slight differences in specific gravity (this is greater in the case of gas tars in general) and in their content of free carbon (the insoluble residue left on extracting tar with solvents like aniline, pyridine, toluene, xylene, etc.).

At first, the tar was nothing but a disagreeable by-product in the manufacture of illuminating gas, which had to be removed at some expense. During the first period of gas making at the beginning of the last century the tar was simply run to waste. Some attempts were made at that time in England to utilize coal-tar by distillation, employing the volatile portions as burning-naphtha and in the manufacture of waterproof clothing, in lieu of turpentine. Crude tar after having been separated from the entangled ammonia water by allowing it to stand for some time was also employed for the purpose of painting iron or steel structural work to protect it from rust, the painting of the sides of the houses to render them damp-proof, and on the roads to allay dust and to increase their wearing properties. For all these purposes, it has now very properly been replaced by partially distilled tar or "refined tar" of which we will speak hereafter. The use of crude tar as a fuel continues, however, up to this day, but only where other uses of tar are too scanty. The burning of the tar is mostly done under the gas-retorts themselves. But at any rate all such attempts to employ crude tar amounts at best only to a local and inefficient outlet for this product. A more extensive industrial employment of coal tar was first opened out by the invention of Bethell in Germany (in the year 1838) for preserving timber, especially railway-sleepers, by impregnation with the heavy oil obtained by distilling tar. One may say that from that time dates the introductioin of tar-distilling on a large scale. A very great impetus was given to this industry by the discovery by Perkin of the first aniline colour, mauve, in 1856, the material which constitutes the starting-point—benzene—being exclusively derived from coal-tar. The new industry of coal-tar dyestuffs required comparatively large quantities of raw materials, especially benzene, and at a later period, naphthalene and anthracene, and this naturally led to a great extension of the distillation of coal tar.

The gas-works remained for a long time the chief source of coal-tar. A very large quantity, however, is now obtained from the coke-ovens and this source may eventually become the predominant one in other countries, India included, as it has already become so in Germany, which country now obtains four fifths of her supply of tar from this source. In recent years a certain amount of tar is also being obtained from the blast furnaces of iron works, but compared to gas-tar and coke-tar this is a very inferior product. But from whatever source it is obtained—from gas-works or coke ovens—the distillation of tar forms a separate industry.

The distillation of tar has for its primary object the removal of non-volatile or too-little volatile constituents from the greater portion of tar, contained in the form of pitch, and to effect a preliminary fractionation of the distillates, which, in their turn, are then worked up singly. This can be done only by a direct fire, since the boiling point of one of the most valuable products from tar, anthracene, coincides with that of mercury (360°) with or without the employment of a vacuum. The distillation can be done either according to the intermittent or the continuous system. At the more up-to-date tar-distilleries in Europe and America, the primary distillation of crude tar is carried out in two phases: (1) dehydration, the purpose of which is to free the tar from the ammoniacal liquor so as to prevent it from boiling over during distillation; the more volatile constituents, *viz.* light oils, are also got off in this process, so that the subsequent distillation of tar proceeds at a quick pace; and (2) distillation, whereby the less volatile oils are taken out.

(*To be Continued*).

Research Notes

Wave-Mechanistic Principle Illustrated in Phenomena of Scattering of Fast Electrons by Atoms and Electrons

In the case of scattering of a particle by another particle the scattering formula is identical for classical mechanics and wave-mechanics if the scattering particle is different from the particle scattered. On the other hand, if both the particles are identical the formula derived on the basis of classical theory comes out to be different from that derived on the basis of wave-mechanics. This difference in formulae from the two standpoints in the case of scattering by like particles is utilized in an experiment designed by A. L. Hughes and S. S. West to determine that the process of scattering of electrons by atoms is obeyed by wave-mechanical laws.

When a beam of electrons impinges on an atom they are scattered in different directions, the scattering centres being the nucleus of the atom and the electrons surrounding the nucleus. The scattering due to the nucleus and that due to the electrons are readily distinguished, by the fact that the electrons lose no energy when they are scattered by atomic electrons. Thus the scattering due to nuclei is called elastic scattering and that due to electrons is called inelastic scattering. Hughes and West (*Phys. Rev.* *50*, 320, 1936) directed a beam of 2000 volts electrons into helium and investigated the ratio of number of inelastically scattered electrons to the number of electrons scattered elastically as a function of the angle of scattering. It was shown in this paper that the results obtained were decisively in favour of wave-mechanical theory. These investigators repeated the experiments replacing (*Phys. Rev.* *52*, 41, 1937.) helium by hydrogen. In the case of hydrogen also their conclusion is that the results are much closer to the values predicted by the classical theory.

Helium is a monatomic gas and hydrogen a diatomic molecule. In the case of helium the beams of fast electrons are scattered by one nucleus whereas in the case of hydrogen by a pair of nuclei put close together and connected by certain internuclear force. Thus the elastically scattered electrons in hydrogen suffers a deviation from the scattering due to helium nuclei, which is explained as due to a sort of diffraction effect caused by two diffracting centres placed near to each other. On account of this diffraction the elastic scattering formula for diatomic hydrogen molecule assumes a factor of the form $[1+(\sin x)/x]$ where x is given by $x=2\pi d \sin(\varphi/2)/\lambda$, in which φ is the angle of scattering, λ the electron wavelength, and d the distance apart of the atoms in hydrogen molecule. Hughes and West showed that adopting a value 0·74A for d, the interatomic distance in hydrogen molecule calculated from well-known experiments, the formula indicated a better fit. Thus it can be claimed by these investigators that they have demonstrated through their scattering experiments a new method of determining the interatomic separation in the case of light diatomic molecules.

S. C. Deb.

Origin of Coal

Lignin, and not cellulose, is considered to be the origin of coal inasmuch as on oxidation bituminous coal yields appreciable amount of aromatic acids which are also obtained from the oxidation products of lignin. Cellulose by a similar treatment gives only simple aliphatic acids. Many investigators maintain the above view—chief among them are Fischer and Schrader, Bone and his co-workers. But recently, Smith and Howard [*J. Am. Chem. Soc.* *59*, 234, 1937], have succeeded in obtaining aromatic products from cellulose as well.

Pure cotton cellulose was carefully heated between 190°-400°, in an atmosphere of nitrogen. The residue of the pyrolysis was converted into water soluble acids on oxidation with alkaline $KMnO_4$. The mixture of acids was then de-carboxylated and among other products, benzene and diphenyl

were detected. With the temperature range up to 300°, the aromatic carbon is of the same order as that from Pittsburgh coal. During thermal decomposition of cellulose it was observed that C_6 ring structures were rapidly formed about 200° and for coalification process 200°-300° seems to be quite a possible range. Hence the presence of aromatic substances in the oxidation products of bituminous coal does not conclusively prove that it is derived from lignin alone. *P. B. Sarkar.*

Eastern Himalayan Blood Groups

Ruggles Gates in his paper on "Tibetan Blood Groups" (*Man*, 1936, 147) stated that the unusually high percentage of 24. 1 % of the group *AB* may be due to Chinese admixture. But the recent data obtained from Kalimpong on the above people by Dr E. W. E. Macfarlane (*Man*, 1937, 159) show the percentage of *AB* to be 5. 3 only. The Tibetans, according to Captain Tennant, who secured the data on behalf of Prof. Gates from Gyantse, show a high percentage of *A* (47. 1 %) while according to Dr Macfarlane they have the highest percentage of O (46. 5 %), that of *A* being 35. 7. Apart from the Chinese admixture as suggested by Gates which may be the case for Gyantse only it may be that blood group relationships differ markedly in different parts of Tibet. Dr Macfarlane also mentions the striking similarity of the Tibetans with the Navajo (American Indian) in physical features and in some designs on cloth as well as their silver and turquoise jewellery. It is remarkable that the Tibetans who have their nearest Mongoloid neighbours in Nepal and China have absorbed very little of *B*, which is found in fairly high percentages among the latter. Macfarlane has also examined blood groups of 78 Nepalis and 25 Lepchas, both of whom have the highest percentages of *A* but are fairly strong in *B*. *S. S. Sarkar.*

Copper Complex in the Role of Ascorbic Acid Oxidase

Subsequent to the description of a "hexoxidase" in cabbage leaves by Szent-Györgyi several investigators have reported the existence of an "ascorbic acid oxidase" in several plants and fruits. Such an "enzyme" was reported to be present in apple juice by Zilva, in the pods of the drumstic by Srinivasan, and in cauliflower juice by Hopkins and Morgan. Kertesz, Dearborn and Mack reported about the destruction by heat of an oxidizing agent in some vegetable extracts. Tauber, Kleiner and Mishkind reported the concentration of a similar factor from Hubbarb squash.

But it had been previously observed that copper acts as a catalyst in enhancing the aerobic oxidation of ascorbic acid *in vitro* and that sodium-diethyldithiocarbamate serves as a copper inhibitor against the aerobic oxidation of vitamin C in aqueous solulion.

An observation that diethyldithiocarbamate completely inhibited the aerobic oxidation of ascorbic acid in cucumber juice, which is very active catalytically, led to a study based on the hypothesis that copper was chiefly responsible for the catalytic effect of "oxidase" preparations.

Stotz, Harrer and King [*J. Biol. Chem. 119*, 511, 1937] approached this problem from two points of view: (*a*) the effect of a series of copper inhibitors upon typical "enzymes" and (*b*) a comparison of the reported "enzymes" with copper plus protein. From the result of their experiment these authors come to very important conclusions. They conclude that copper may be combined with proteins in such a manner that it retains its catalytic role in the oxidation of ascorbic acid and that the catalytic activity of squash and cauliflower juices on the oxidation of ascorbic acid, previously ascribed to a specific "oxidase", is due to the copper present in combination with protein material. Copper inhibitors have been found to produce nearly complete poisoning of the "enzymes" and a mixture of copper and albumin assumes the characteristic properties of the "enzymes". Although this particular paper deals with results obtained with cauliflower juice, purified squash "oxidase", cucumber juice and cabbage juice, the authors suggest that the other "ascorbic acid oxidases" described in the literature are probably not essentially different from these. A study of several other vegetable and fruit juices will surely verify the above conclusion. *H. N. B.*

University and Academy News

Indian Chemical Society

An ordinary meeting of the Indian Chemical Society was held on the 7th September 1937, in the Chemistry Lecture Theatre, University College of Science, Calcutta.

Prof. J. C. Ghosh, President, was in the chair.

The following gentlemen were admitted as Fellows of the Society, their subscriptions having been received for the first time.

(1) Constant Willem Pieter Van der Meydern, Esq. Imperial Institute of Sugar Technology, Cawnpore, (2) Dr Asoke Nath Bose, B Sc., Dr. Ing. 1, Woodburn Park, Calcutta (3) Dr E. McKenzie Taylor, M. B. E., Ph. D., D. Sc., F. I. C. Director, Irrigation Research Institute, P. W. D., Lahore; (4) Bala Krishna Menon Esq. M. Sc. A. I. I. Sc. University College, Rangoon, Burma; (5) Maung Po Tha, Esq. M. Sc., University College, Rangoon, Burma; (6) Yeo Sein Gwan, Esq. B.Sc., University College, Rangoon, Burma; (7) Maung San Tun, Esq. B Sc. University College, Rangoon, Burma; (8) Champa Lal Esq. Executive Engineer, Ludhiana; (9) K.L. Roy, Esq. M.Sc. 92, Upper Circular Road, Calcutta.

The following gentlemen were elected as Fellows, Mr P. Ray and Dr J. N. Mukherjee acting as scrutators.

(1) Sailesh Chandra Sen, Esq. M.Sc. Sugarcane Research Station, Pusa, Bihar, (2) M. Raman Nayar, Esq. B A., A.I.I. Sc. Lecturer in Chemistry, Lucknow University, Lucknow. (3) Dr. P. N. Brahmachari, M.Sc. M.B., P.R.S., 82/3 Cornwallis Street, Calcutta. (4) K. R. Aggarwal, Esq. B.Sc. Tech. 10, Street, Jullundur Cantt.

Dr. U. Basu, read a paper on "Acridine derivatives as antimalarials".

Prof. J. C. Ghosh delivered a lecture entitled "The Directing Influence of Light in the process of aggregate formation".

Anthropological Society

The second ordinary meeting of the Anthropological Society was held on the 10th August, 1937 in the Anthropological Department, Calcutta University, at 4-30 p.m. Mr J. K. Bose read a paper on "Effect on culture contact on the "Garos" under the presidency of Prof. K. P. Chattopadhyaya. Messrs T. C. Roychowdhury, N. K. Bose, T. C. Das. M. N. Basu and others joined in the discussion.

The National Academy of Sciences, India

The ordinary monthly meeting of the National Academy of Sciences, India, was held in the Physics Lecture Theatre, Muir College Buildings, Allahabad, on the 13th August, 1937, at 4 p.m. Prof. D. R. Bhattacharya, Vice-President of the National Academy, was in the Chair.

The National Academy of Sciences, India, expressed its great sorrow at the sad and untimely demise of Mr K. P. Jaiswal, Bar-at-law, Patna, a member of the Academy.

It was decided to award the Education Minister's Gold Medal in Mathematics this year.

The following papers were read and discussed :—

1. On the Salivary glands in the order Coleoptera, Part I., The Salivary glands in the family Tenebrionidae, by Mr R. L. Gupta, Lucknow University.
2. New Strigeids (Trematoda) from Indian Birds, by Mr R. D. Vidyarthi, Allahabad University.
3. The Mathematical Theory of a New Relativity, Chapter XV, The Rotational Theory of Light and Matter, by the Hon'ble Sir Shah Muhammad Sulaiman, Kt., Chief Justice, High Court, Allahabad.
4. On Parachor and Thermal conductivities of Metallic elements, by Mr Binayendra Nath Sen, Burdwan Raj College, Burdwan.
5. The Inverse Square Law, a demonstration, by Mr Saiyid Muhammad Muqtadir, Allahabad.
6. Fungi of Mussoorie, Part I., by Prof. J. H. Mitter and Mr R. N. Tandon, Allahabad University.

Letters to the Editor

The Effect of Vitamin C and other reducing Substances on certain Toxins.

The inactivation of diphtheria toxin by vitamin C *in vitro* has been investigated by several workers[1] and also recently by us, especially with reference to the machanism of the inactivating effect as exerted on diphtheria and tetanus toxins. One m. l. d. of diphtheria toxin is incapable of producing symptoms in guinea-pigs if it is previously mixed with 25 mg of ascorbic acid. In an investigation of the nature of this neutralizing action the effect of mixing the toxin with other reducing substances like cysteine, glutathione and hydroquinone was studied. These reducing agents were likewise found capable of inactivating the toxin. Similar results were obtained with tetanus toxin, and ascorbic acid, cysteine, glutathione and hydroquinone were all found to produce the same inactivating effect (Tables I & II). The animals which are stated in the tables to have survived are still healthy even after 1-2 months. The inactivation may, therefore, apparently be due to the reducing action. Similar results have been obtained by Grootten and Bezssonoff[2] in their study of the effects of ascorbic acid and hydroquinone on whooping cough bacillus. Injection of ascorbic acid after injection of the toxins also appears to produce a favourable effect.

It would seem that the use of reducing substances like ascorbic acid, cysteine and glutathione affords therapeutic possibilities in infections of the type mentioned above. The subject is under further investigation, particularly with

TABLE I

DIPHTHERIA TOXIN.

Weights of guinea-pigs (in g)	Control (1.m.l.d. toxin). survival period	1 m l.d. toxin mixed with: Ascorbic acid (50mg)	Ascorbic acid (25mg)	Glutathione. (25mg)	Cysteine (25mg)	Hydroquinone. (25g)
265	4 days	..	..	..	..	..
315	2 ,,	..	..		..	..
300	3 ,,	..	..	..	..	
265	5 ,,	..	..	..	..	..
245	3 ,,	..	..	..	..	..
265	..	..	..	..	..	died after 10 days
				..	..	
260	..	..	..			survived
260	..	..	..	survived	..	..
200	..	..	..	died	..	..
280	..	..	..	..	survived	..
260	..	..	..	..	-do-	..
265	..	..	survived	..	..	..
270	..	..	-do-	..	..	..
250	..	survived	..	..	..	..
280	..	-do-	..	..	..	..

TABLE II

TETANUS TOXIN.

Weights of guinea-pigs. (in g.)	Control (1 m. l. d. toxin). survival period	1 m. l. d. toxin mixed with: Ascorbic acid (100 mg.)	Ascorbic acid (50 mg.)	Ascorbic acid (25 mg.)	Hydroquinone (25 mg.)	Glutathione (25 mg.)	Cysteine (25 mg.)
280	4 days	..	..	..	..	..	..
295	..	..	..	..	..	..	..
282	..	survived	..	..	..	..	..
270	,,	-do-	..	..	..	..	..
290	..	-do-	..	..	..	..	..
280	..	..	survived	..	..	..	..
275	..	..	-do-	..	..	..	..
270	3 days	..	..	..	..	..	..
275	,,	..	..	..	..	..	..
295	..	..	..	survived	..	..	..
260	..	..	..	-do-	..	..	..
265	..	..	..	..	survived	..	..
290	..	..	..	..	-do-	..	..
290	..	..	..	..	..	..	survived
270	..	..	..	..	..	survived	..
260	..	..	..	..	..	-do-	..

reference to the effect of the ingestion and injection of these reducing substances on the course of the intoxications.

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Calcutta.
14.9.37

B. Ghosh.
B. C. Guha.

1. King and Menten, *J. Nutr.*, *10*, 137, 141, 1932; Otto, *Klin. Woch*, *15*, 1510, 1936.

2. Grootten and Bezssonoff, *Ann. Inst. Pasteur*, *56*, 413, 1936.

The Role of Carotene in Metabolism of Fats

The seasonal variations in the Reichert values, iodine numbers, carotene and vitamin-A contents of butter fats have been studied. About 6 to 15 samples prepared in each month were analysed for the above values and it was observed that these values tend to be higher in winter (November to February) than in autumn (July to October). *Prima facie*, the results obtained are contradictory to the data obtained in Western countries where the lowest Reichert values and carotene contents of butter fats have been obtained in winter. These facts led the author to suspect that factors other than the climate or lateness in the period of lactation of the cows are probably playing some role in the modification of the Reichert values and iodine numbers of butter fats. The nature of the feeding stuff is perhaps the predominant factor, for it undergoes considerable changes during the rains and in winter, particularly in its carotene content. In the eastern parts of Bengal (Vikrampore, Dacca), wherefrom the author purchased all his samples, the pasture lands are under water during the rains, and the cows live mainly upon hay and straw of low carotene content (0.28 mg per 100 g.) and a small amount of concentrates like rice-meal and oil-cakes. On the other hand, during winter (unlike what happens in European countries) the actual grazing period begins and the pasture fields are now full of grasses and leafy vegetables of high carotene content (2 to 8 mg of carotene per g.). The above facts are of considerable physiological importance, for apart from several influencing factors, the Reichert value indicates the extent to which the oleo-glycerides present in blood have undergone oxidation and iodine number is a measure of the difference between the desaturation and oxidation processes which form the basis of fat metabolism in the the living organism.

The detailed paper will be published elsewhere shortly.

My best thanks are due to Principal T. C. Byod for his kind encouragement.

Department of Chemistry,
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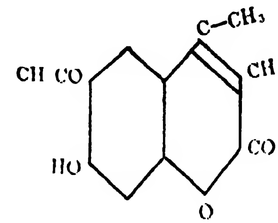
13. 9. 37.

Sailendra Mohan Das Gupta.

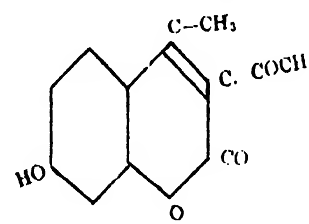
Condensation of Resacetophenone with Ethyl Acetoacetate

Agarwal and Dutt[1] condensed resacetophenone with ethyl acetoacetate using either sodium ethoxide or sulphuric acid as the condensing agent and isolated 7-hydroxy-6-acetyl-4-methyl coumarin (I).



(I)

The above reaction may also produce 7-hydroxy-3-acetyl-4-methyl coumarin (II) as in the case of the condensation of β-resorcylaldehyde with acetoacetic ester[2].



(II)

While studying condensations of this type we have found that resacetophenone does not condense with ethyl acetoacetate in presence of alcoholic sodium ethoxide (*cf.* Desai and Hamid[3]) under the experimental conditions of Agarwal and Dutt[1] and the product isolated by them after crystallization from benzene, m. p. 147°, is found to melt at 142° and is unchanged resacetophenone, and it does not depress the m.p. of resacetophenone. Further on Clemmensen's reduction it gives ethyl resorcinol (m. p. and mixed m. p. 97°), which condenses with ethyl acetoacetate to give 7-hydroxy-6-ethyl-4-methyl coumarin (m. p. 210°) identical with the coumarin obtained from ethyl resorcinol prepared by Clemmensen's reduction of pure resacetophenone.

It is peculiar that Agarwal and Dutt's so-called 7-hydroxy-6-acetyl-4-methyl coumarin (I) differs in all

respects from 7-hydroxy-6 acetyl-4-methyl coumarin discribed previously by Limaye and Gangal[4]

7-Hydroxy-6-acetyl-4-methyl coumarin (Limaye and Gangal[4])	7-Hydroxy-6-acetyl-4-methyl coumarin (Agarwal and Dutt[1])
m.p. 210°	m.p. 147°
Semicarbazone, m.p. above 300°	Semicarbazone, m. p. 183°
Acetate, m.p. 172°	Acetate, m.p. 120-21°

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20. 9. 37.

D. Chakravarti.
N. Chakravarty.

1. Agarwal and Dutt, *J. Indian Chem. Soc*, *14*, 109, 1937
2. Weiss and Merksammer. *Monatsh*, *50*, 115, 1928.
3. Desai and Hamid, *Current Science*, 56, 1937.
4. Limaya and Gangal, *Rasayanam*, *1*, 20, 1936.

Molecular Deformation at Low Temperatures

Pyramidal molecules of the type YX_3 where X is a polarizable atom like chlorine, are being investigated at the temperature of liquid air, with the help of their Raman spectra, to examine any deformation of the pyramid under the influence of 'crystalline' forces due to the solid state. Interesting results have been obtained with some of the tri-halides of the elements of Group V in Mendeleeff's periodic table, in that several degenerate frequencies arising from the symmetrical nature of the pyramid configuration are observed to split up into their components. The results for phosphorus tri-chloride have been published and discussed in detail[1]. Below are given in short the results at different states and temperatures for arsenic and antimony trichlorides.

$AsCl_3$ liquid (31°C)—$\Delta\nu$	158	195	370	405
Intensity and nature—	(5)	(2s)	(5b)	(6s)
Symmetry character—	E	A_1	E	A_1
$AsCl_3$ solid (-180°C)—	155, 168	196	357, 373	392
$SbCl_3$ solid (31°C)—	147	171	312	338
$SbCl_3$ solid (-180°C)—	138, 151	178	310, 317	338

It is to be noted, from the results with antimony chloride, that the degree of splitting of the degeneracy is influenced by temperature, and is not solely determined by the state of the substance only.

Investigations are in progress with similar molecules, and results are to be reported shortly elsewhere

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Calcutta,
7. 9. 37.

Jagannath Gupta.

1. Sirkar and Gupta, *Ind. J. Phys*, *11*, 55, (1937).

On the Opisthecoelous Vertebra in Birds

Regarding the shape of the vertebrae in birds Goodrich in his book *Structure and Development of Vertebrates*, published in 1930 has stated on page 63, "Opisthocoelous vertebrae occur in some carinate such as Penguins, Auks, Parrots, Darters, and Cormorants; and procoelous vertebrae more rarely in the tail (Parker). But the characteristic and usual articulation is saddle-shaped (heterocoelous)."

Recently in connection with my study of the vertebral column, I found that in a parrot *Palaeornis torquatas* the cervical vertebrae are all heterocoelous. It is only the thoracic vertebrae that are all opisthocoelous. On consulting literature I could find that as far back as 1896 Newton in his book *A Dictionary of Birds*, page 850 stated the same thing regarding opisthocoelous vertebrae in Psittaci,

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3. 9. 37

Himadri Kumar Mookerjee.

A Note on the Analytical Proof of Kirchoff's Law

In a recent issue of SCIENCE AND CULTURE[1], Mr B. Mukhopadhyay has given what he considers to be an analytical proof of Kirchoff's Law, that "radiation emitted by the wall of uniform temperature enclosure at any point inside it is the same everywhere, *i. e.*, independent of the position of the point with respect to the walls of the enclosure." Stated in other words, the law means that the *radiation density* is the same at every point inside a uniform temperature enclosure.

The point of the present letter is to point out that no purely analytical proof, as Mr Mukhopadhyay (if I understand him aright) claims to have given, can be provided for. It is well known that to prove Kirchoff's law the second law of thermodynamics has to be introduced at one stage or the other of the argument. *To prove Kirchoff's law an appeal has always to be made to the second law of thermodynamics* (as can be seen in any standard text book on thermodynamics).

The fallacy that Mr Mukhopadhyay makes in his proof is to assume that "for temperature equilibrium the heat

received must be the same for all positions of the sphere." The sphere referred to above is a small test-sphere put at any point inside the enclosure. Now this assumption is obviously wrong. For, temperature equilibrium means that ***the heat received by the test-sphere must equal the heat emitted,* and not that the heat received must always be the same***, as assumed by the author in his letter quoted above.

On the assumption that the heat received is the same the so-called "analytical proof" of Kirchoff's law follows at once; but the assumption is fundamentally incorrect. A correct derivation of the law must make use of the second law of thermodynamics, and cannot be purely analytical.

Oswal Jain High School,
Ajmer.
12. 9. 37.

Duleh Sinha Kothari.

1. SCIENCE AND CULTURE, 3, 118, 1937.

* This simply is a statement of the first law of thermodynamics (energy-conservation) applied to the body receiving and emitting heat, for if the thermal state of the body remains stationary, *i. e.*, its internal energy remains constant, then the first law requires that the heat received must equal the heat emitted. Mr Mukhopadhyay's assumption has no such justification.

Magnetic Properties of Cobalt Oxide

Co_3O_4 was prepared by heating cobalt nitrate and its magnetic susceptibility (χ) determined at different temperatures. As appears from the table below χ changes slightly with each heating.

TABLE I.

First heating		Second heating	
Temp. (°c)	$\chi.10^6$	Temp. (°c)	$\chi.10^6$
33	28.9	31.4	25.9
134	23.4	126	20.9
203	20.8	191	19 4
280	18.7	266	17.5
324	15.6	328	16.5
369	15.0	375	14.9
406	13.9	407	14.2
431	13.4		

The mass susceptibility at room temperature as obtained by us is definitely lower than the values given in the *International Critical Tables*. The $\frac{1}{\chi}$. T graph is convex towards the temperature axis.

The oxide was then heated to 900°C for four hours. The value at room temperature increased; but was found to be the same in different magnetic fields, showing that there has been no decomposition into a ferromagnetic component. Analysis gives a formula CoO. xO, where x=.06. Effect of temperature on the product of heating shows that the $\frac{1}{\chi}$. T is practically straight with in the range investigated i.e., from room temperature to 330°C. The values are given in the next table (sample I).

Another sample of Co_3O_4 was prepared by allowing cobalt formed by electrolysis at mercury cathode to oxidize slowly. But the product was found to contain some metallic cobalt which did not oxidize easily. It was then heated to 900°C for 2½ hrs at the first instance and then again for 1½ hrs, and χ determined at different temperatures each time. The values are given in the table below under sample II and sample III respectively.

Results of sample II shows that oxidation is not yet complete. Analysis of sample III shows that the formula may be represented by CoO. xO, with x=·20. Samples I and III contain mostly CoO with slight excess of oxygen. The value for pure CoO is, therefore, about 60.10^6. The *International Critical Tables* give $14.5.10^{-6}$ for this value. Klemm and Schuth[1] finds in CoO a transition between ferro- and paramagnetism,

TABLE II

Sample I		Sample II		Sample III	
Temp. (°c)	$\chi.10^6$	Temp. (c°)	$\chi10^6$	Temp. (°c)	$\chi.10^6$
31.3	59.9	30	71.0	31.7	58.7
123	53.1	115	62.2	116	52.4
182	49.0	164	58.1	169	47.3
251	44.5	242	51.3	223	43.1
330	41.6	298	47.0	281	39.2

It is difficult to say in what state this excess oxygen occurs in the compound. It can either be combined in the form Co_3O_4, or may be dissolved in CoO. X-ray methods are being applied to investigate this point.

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17.9.37

A. K. Bose.
D. P. Ray-Chaudhuri.

1. W. Klemm & W. Schuth, *Zeit. f. anorg. u. allg. chem.* **23**, 210, 1935.

LETTERS TO THE EDITOR

On the So-called Coulsonite

With reference to Dr P. B. Sarcar's letter on "coulsonite" in the August number of SCIENCE & CULTURE, p. 122, I would point out that in Dr J. A. Dunn's and my paper[1] we clearly stated that Mr N. Ray detected vanadium during his analysis of the Dublabera ore before it had been confirmed by the Imperial Institute or the Geological Survey of India, and in the discussion (p. 193) I again stated that its presence had first became known after analysis made at the University College of Science, quoting the precis of Mr N. Ray's paper in the *Proceedings* of the 19th Indian Science Congress (1932) p. 212, though pointing out that the locality is not given in the precis. This is the only published account of Dr Sarkar and Mr Ray's investigations, of which we are aware, and runs as follows :

> "Chemical examination of some vanadiferrous ilmenites of India", by Nirmalendunath Ray. calcutta.
>
> "Vanadium was discovered a century ago in certain Taberg (Smaland) iron ore. Certain ilmenites have been found to contain traces of vanadium. The author has recently examined a few specimens of Indian ilmenites which are characterized by their high percentage (5%) of vanadium. Complete chemical analysis has been done and its composition determined". (*Proc. of 19th Indian Science Congress*, p. 212, 1932).

Apart from the omission of the locality, and of any reference to Dr Sarkar's name, it must be admitted that the "few specimens" of the precis does not quite give the impression of "over 30 samples" on which Dr Sarkar's letter informs us the analyses were made. We have given full credit to Mr Ray as being the original analyst of these vanadium-ores and Dr Sarkar should not blame us for "hiding his light under a bushel", when his name was not published in the only account of the investigations available to us. His chemical analyses were made on aggregates of the many minerals listed in our paper, whereas we have shown that the vanadium in these mixtures is contained in a definite mineral isomorphous with magnetite. We do not claim "coulsonite" to be a species but rather a variety. We are content to leave the mineral as described to the approval of mineralogists, and for the remainder of Dr Sarkar's letter must refer him to our paper and the discussion thereon, and to mineralogical literature more recent than 1899.

Geological Survey of India,
Calcutta.
14. 9. 37

A. K. Dey.

[1] *Trans. Mining & Geol. Inst of India*, XXXI, Pt. 3. p.120)

SCIENCE AND CULTURE

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VOL. III. NO. 5

NOVEMBER 1937

Annual Report of the Imperial Council of Agricultural Research—1936-37

THE Imperial Council of Agricultural Research was established seven years ago on the recommendation of the Royal Commission on Agriculture. Under the able guidance of Sir T. Vijayaraghavacharyya and Sir Bryce Burt, the Council has not only initiated researches of far-reaching character and revitalized the research sections of the provincial agricultural departments, but has also been able to enlist the co-operation of university professors in solving problems of fundamental interests.

With the Chairman of the Royal Commission on Agriculture installed as the Viceroy of India, the activities of the Council have naturally received a further impetus. Though agriculture is a provincial subject, the expenditure of the Central Government on agricultural research is steadly increasing, and during the year under review, the actual expenditure on research schemes alone has amounted to 17 lakhs of rupees. This expenditure is exclusive of the cost of maintenance of the Imperial Institute of Agricultural Research at Delhi and its substations, the Imperial Institute of Veterinary Research at Muktesar, the Institution of Animal Nutrition at Izatnagar and the Imperial Institute of Sugar Technology at Cawnpore, and the costs of the headquarters' staff with the Government of India. Periodical review of the researches carried out under the auspices of the Imperial Council of Agricultural Research by competent experts abroad was considered desirable with a view to find out if the progress has been satisfactory, if the schemes of research could be better co-ordinated, and if the funds at the disposal of the Council could in any way be better utilized. At the invitation of the Council Sir John Russell and Dr Wright visited India during the last cold weather. They came in personal contact with the research workers in agricultural and veterinary sciences and discussed their programmes of work in detail. Their reports have just been published and a short summary is given elsewhere in this issue.

Expenditure on research schemes relating to Sugar Industry is the largest single item in the budget for 1936-37. A sum of 3 lakhs of rupees approximately has been provided to finance (*a*) sugar cane research station in the various provinces, and (*b*) schemes of research relating to cane diseases, structural anatomy of sugar-cane and genetics of sugarcane and (*c*) for the supply of technological and marketing information. Perhaps the most important advance in the direction of sugar research was the decision to convert the sugar section of the Technological Institute at Cawnpore into an Imperial Institute of Sugar Technology at an estimated cost of 14 lakhs of rupees spread over a period of 5 years. It is in the interest of the country at large and also of

the manufacturer of sugar that schemes of sugar research should be liberally financed. The Government of India used formerly to derive a revenue of 10 crores of rupees from import of sugar. That income has almost been wiped out completely in view of the high tariff wall, and the newly imposed excise duty has been a very inadequate compensation. Heavy responsibility has therefore devolved on those who are responsible for sugar research and for the training of sugar technologists. The Nation expects of them speedy results--results which will enable the Indian sugar industry to hold its own in the home market more or less on free competitive terms.

The next single largest item of expenditure relates to marketing schemes which absorb about 2 lakhs of rupees. The All-India Report on the marketing of wheat was published in April 1937. Marketing surveys of other commodities, *e.g.*, rice and paddy, linseed, groundnuts, tobacco, barley, hides and skins, eggs, etc., are in progress and it is hoped that the reports embodying the results of these surveys will soon be available. The Agricultural Produce Grading and Marking Act of 1937 empowers the Governor-General in Council to make rules *inter-alia*, for grade designations defining the quality of agricultural produce. It is to be hoped that these activities will bring lasting benefit to the ryots of India. Considerable doubts have however been expressed in responsible quarters whether these marketing surveys will be of any value if they are not linked up with the corresponding development work in the provinces in association with co-operative marketing societies. The fate of the Empire Marketing Board in the United Kingdom, of which these Indian marketing organizations are really offshoots, does not encourage the hope that in India also their activities will be less critically judged, and the Imperial Council of Agricultural Research will do well to take frequent stocks of what is being actually done in the line.

The co-ordinated schemes relating to rice research cost the Council Rs. 175,000/- approximately. The research stations are located in the major rice growing provinces of Bengal, Bihar, Orissa, Madras, U. P., and Burma. Hybridization work for better yielding varieties, or for vaieties which conform to specific trade requirements like the Blue-rose, is now generally in the fourth year and points to promising results. Much valuable information has been obtained regarding the age of seedling for transplantation, the nutrition of the rice-plant and the conditions favourable for maximum grain-formation.

A sum of 90,000/- has been provided for fruit research schemes in the various provinces, including researches on the diseases of the cocoanut palm in Travancore. The Royal Commission on Agriculture drew attention to the need of extending cold-storage facilities in the marketing of perishable agricultural produce. The Imperial Council of Agricultural Research built some time ago a cold-storage station at Poona with a view to facilitate the export of mango to England. Considerable developments have taken place during the year in this direction due in a large measure to the active interest of the army authorities in the problem of refrigerated transport. The Indian Cold-storage Company has been formed for the erection of cold-storage depots at about a dozen places in north-west India, and the I. C. A. R. have been placed in funds up to one lakh of rupees for helping this project.

Another problem which has engaged the serious attention of the I. C. A. R. is that of dry-farming. The distribution of rainfall in India is very uneven. Besides the rainless tracts of Sind and Rajputana, there are areas in Bombay, Madras, the Punjab, and Central India, where the rainfall is scanty, and successful agriculture depends chiefly on conservation of moisture in the soil and on discovering of drought-resisting varieties of plants. Trials with jower, setaria, sorghum, safflower, etc., are in progress. This chain of dry-farming stations are being maintained at an annual cost of Rs. 75,000/- approximately.

The sands of Sind, Baluchistan, and Rajputana are of no economic value to the agriculturist, but they have to be watched carefully as they are the breeding places of the desert locusts. The activities of the locusts of the ' solitary phase ' type were kept under observation on an intensive scale; an instance of ' incipient ' swarming was observed in

the Kolwa area in February-April 1936. The problems of mass multiplication and migration are being studied along promising lines, and we hope in a future issue to publish an article on Locust Research in India and its relation to international attempts at locust control.

The keen personal interest of His Excellency the Viceroy has given considerable impetus to the activities of the Council in improving Indian livestock. It is gratifying to note that the Animal Husbandry Wing of the Board of Agriculture has taken important decisions for the supervision of castration, vaccination and other livestock improvement works and for combating diseases amongst cattle. Many healthy breeds of cattle have been practically extinct from India for want of proper care, and the first duty of the Council has been to carry out propaganda work for improving Indian livestock. The Council has very rightly decided to adopt this measure as part of their programme for the improvement of domesticated animals. In connection with this problem, the decision of the Council to look into the question of fodder crops and to take steps for improving the dairy industry is very welcome.

The Council has spent a sum of Rs 120,000/- approximately for the investigation of the diseases of animals in the provinces, and their mode of prevention. The newer methods which have been developed for the vaccination of cattle against rinderpest appear promising.

The problems of animal nutrition are receiving considerable attention. It has been decided to establish an Institute at Izatnagar and to finance the scheme on a generous scale. Work on animal nutrition has also been started in Bengal, Bihar, U. P., and Assam.

The research schemes under the I. C. A. R. in the University of Dacca is concerned with the mechanical analysis of lateritic soils and study of their physico-chemical properties, as also the nutrition of rice-plants. In connection with the work under this scheme, the fixation of nitrogen by rice plants, when water-logged and exposed to the sun, have been established with Faridpur and Dacca soils.

At Calcutta, Prof. J. N. Mukherjee has been carrying on researches into the properties of colloid soil constituents. At Allahabad, Prof. N. R. Dhar has been carrying on researches on nitrogen loss and nitrogen fixation in soils. At Bangalore, in the Indian Institute of Sciences, experiments are being carried out on the preparation of cheap synthetic manure from town refuse and other materials.

A five years' scheme for research on the synthetic cultivation of medicinal plants and study of food poison has been commenced in 1935, under the direction of Lt. Col. R. N. Chopra of the School of Tropical Medicine, Calcutta. The purpose of this scheme is to investigate into the means by which crude drugs and prepared medicines which are imported in large quantities from outside, could be profitably grown and manufactured within the country. The first progress report for the year 1935-36 has been received by the Council and considered to be very satisfactory.

The work of Prof. Mehta on cereal rusts has established that yellow rust is capable of oversummering in the hills at high altitudes in the form of underspores on self-sown barley and wheat, while brown and black rusts can oversummer at still lower altitudes. All the evidence relating to first date of rust appearance in the plains, and to exposure of aeroscopic slides supports the view that infection takes place every year by spores carried by the wind from the hills to the plains. Attempts are being made to develop rust-resisting strains of wheat, and it is hoped that results of considerable economic value will be obtained in near future.

The review of the activities of the Council of Agricultural Research indicates the many directions along which important investigations have been undertaken. It is too early to express our opinion as to the ultimate benefit which the Indian ryot will derive from these researches in the domain of plant industry and animal husbandry. Success, however, will not be long in coming, if the directing minds have been carefully chosen, if there is efficient teamwork and if every worker is imbued with the determination that he will return thousandfold to the poor tax-payer what is being spent for him as salary and for facilities for research.

The Mystery of Cosmic Radiation—Part IV

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The Supernova Theory of Origin of Cosmic Rays

A NEW theory which attributes the origin of cosmic radiation to the "supernova" process has attracted a good deal of attention in recent years. The sudden appearance of a nova or new star is a comparatively familiar phenomenon of astronomy;* Bailey estimates that in the Milky Way system ten to twenty novae flash up every year, while according to Hubble the frequency of novae in the Andromeda nebula is nearly 30 per year. But the supernova phenomenon is rather rare; one supernova in a thousand years in any stellar system is a fairly good estimate. In astronomically recent times there has been one unmistakable supernova in our Milky Way system, namely, the famous nova of 1572 A.D. (N. Cassiopeiae 1572) which was so bright that it was easily visible at midday. It was this nova which induced the famous astronomer Tycho Brahe to dedicate his life to the service of astronomy.

But what is a "supernova"? In a general way, we may say that it is an exaggerated case of the common novae. A common nova is an obscure or hardly visible star which suddenly blazes up, indicating that some sort of catastrophe has occurred in the heavens. The present century has been rich in common novae, such as Nova Persei, Nova Aquilae (1918), Nova Pictoris (1925), Nova Herculis (1931), etc. These stars have the same general history of appearing very suddenly and fading away more or less gradually; of exhibiting quite a different spectrum for the first few days from afterwards and fading away eventually to the same obscurity from which they had sprung. But they have individual peculiarities and their spectra, which are changing all the time, are very difficult to interpret. During its active stage, a nova gives out about a hundred thousand times more light than in its normal stage and after a period extending over several months or even years it dwindles down into a faint variable which it doubtless was before the outburst. The total light emitted by a common nova is very large for its mass, but still not comparable to it. We of course make use of the fact that mass and energy are equal, being given by the Einstein formula $E = mc^2$, where c is the velocity of light. When a luminous body radiates, it loses mass. For example, the loss of mass by the sun due to radiation is about 4,200,000 tons per second which is roughly $1{\cdot}0^{21}$ of its total mass so that if the sun continues to radiate at its present rate it will lose half its mass in about 10^{13} years. The out bursts of light in a common nova are not so immensely greater than those in some of the variables that they must, without doubt, be ascribed to different causes. Yet it is not easy to assign them to the same cause, for the spectra of new stars are very different from those of long period variables. But the case of the supernova appears to be quite distinct from that of the common nova, because in a supernova process, practically the entire mass of the star appears to dissolve away into radiation.

In 1934 Baade and Zwicky, two Californian astronomers, found that a nova had appeared in the Andromeda nebula in 1885 which had apparently given out an extraordinarily large amount of radiation. They estimated that N Andromedae 1885, which had an absolute brightness of $-14{\cdot}7$ at maximum, emitted during the 25 days of its maximum brightness a total amount of radiation, visible and invisible. of between $12{\cdot}3\times10^{54}$ ergs and $2{\cdot}99\times10^{51}$ ergs which corresponds to a loss of mass lying between $1{\cdot}37\times10^{34}$ gms and $3{\cdot}32\times10^{30}$ gms. Thus assuming that the original star which flared

* An account of the nova phenomenon was given by Prof. A. R. Khan of Hyderabad in SCIENCE AND CULTURE, Vol. I, Pages 489-492.

up as a nova has the same mass as the average run of stars (10^{34} gms to 10^{35} gms), the remarkable fact emerges that during the outburst, a good fraction of its energy was burnt out as visible radiation. But there is a considerable degree of ionization of gaseous shells which are expelled from a nova during an outburst; consequently a vast amount of ultraviolet radiation must be emitted during the process. Thus it can be argued that during a nova outburst of this type (supernova phenomenon!) the entire mass of the star or a good fraction of it dissolves away into radiation. Baade and Zwicky further showed that the energy emitted during supernova outbursts might suffice to account for the whole energy of cosmic rays. They assume that a typical supernova outburst gives out a stupendous amount of energy, $E=10^{53}$ to 10^{54} ergs and that there is one supernova outburst per 1000 years per galaxy. Now, the distribution of galaxies in space corresponds approximately to one galaxy in a cube of one million light-years, and consequently we get for the density of energy emitted by a supernova $\sigma = ED/8\, l^3\tau = 0{\cdot}8\times10^{-3}$ to 8×10^{-3} ergs/cm^3/sec. where $D=2\times10^9$ light-years, $\tau=1000$ years and $l=10^6$ light-years. This estimate is in remarkably good agreement with the intensity of cosmic rays falling on the earth (viz., $3-4{\cdot}10^{-3}$/sec./cm^2) as measured by Regener (1933), Millikan, Bowen and Neher (1933). Thus the supernovae appear to be quite probable sources of cosmic radiation. But it should be pointed out that there are certain obscure points in the above arguments. First of all Baade and Zwicky's estimate of 10^{53} to 10^{54} ergs for the energy emitted in the ultra-violet by a typical supernova is derived from the case of N Andromeda 1885. But it is not certain that this nova really belonged to the Andromeda galaxy, for there is a possibility that it might have been a star of our own galaxy and its location in the Andromeda galaxy might be merely an effect of perspective; if this be the case, the whole argument falls to the ground. In fact, no unambiguous case of supernova has so far been established. Secondly, in supernova outbursts, even if Baade and Zwicky's arguments be correct, the radiation is emitted in the form of X-rays and γ-rays. But cosmic rays consist principally of electrons and positrons. It is not clear how the X-rays and γ-rays are converted into electrons and positrons in this process.

Can Ordinary Nova Emit Cosmic Radiation?

If a supernova can emit cosmic rays, should not the common novae be expected to account for at least a part of the cosmic ray intensity actually observed on the earth? Of course a common nova cannot certainly produce as much cosmic radiation as a super-nova, but we have to consider the greater frequency of occurrence of the common novae. The general data regarding the distribution of novae indicate that the Milky Way and the spiral nebulae present the most favourable conditions for their occurrence and also that the galactic and nebular novae are essentially of the same nature. Bailey estimates that in our galaxy (Milky Way), ten to twenty novae flash up every year, while according to Hubble the frequency of appearance of novae in the Andromeda nebula is 30 per year. But the actual frequency of novae in these systems is sure to be greater due to the fact that all the novae are unlikely to have been caught and in many of them the maximum may have been missed in the photographs on which the estimates are based. Thus it seems possible that the intesity of cosmic radiation actually observed on the earth may be produced by the combined effect of all the novae even though only a small amount of cosmic radiation might be emitted by the individual novae. In fact, in 1934-35 measurements of cosmic ray intensity at various places in Europe shewed an appreciable increase of cosmic radiation during the period when Nova Herculis (1934) fluctuated about its maximum brightness. The observations of W. Kolhörster, A. K. Das, W. Messerschmidt and others (all made with different kinds of apparatus) seemed to indicate that the Nova Herculis was responsible for about 2 to 4 per cent. of the total cosmic radiation, for it was found that the intensity was maximum (in a 24 hour period) when the nova was at its highest altitude and minimum when the nova was lowest. It has been argued by some that the observed increase in cosmic ray intensity need not be an effect of the nova outburst, since the Sun was at its highest altitude at about the same time as the nova, at least in December 1934. But the later observations of A. K. Das in February-March

1935 when the nova and the Sun were well separated in hour-angle shew that the observed effect was certainly not due to the Sun; in any case, it was too large to be explained away as a solar effect. It should be mentioned however that Hess and Steinmaurer as also Barnothy and Forro found a much smaller effect than the authors mentioned above. Consequently the question whether a common nova actually emits cosmic rays cannot be said to be settled. Recently (December 1935) some experimental evidence indicating the super-novae as producers of cosmic rays has however been brought forward by H. Zanstra.

Zanstra points out that the corpuscles emitted during the super-nova process ought to reach the earth later than when the outburst is actually observed, for the corpuscles travel with a velocity smaller than the velocity of light. If these corpuscles (identified as cosmic rays) are assumed to be protons*, then the time-difference between their arrival at the earth and the arrival of the light signal of the nova outburst may be appreciable. He considers two super-novae *viz.*, N Andromedae 1895 (distance $0{\cdot}8\times10^{6}$ light-years) and the super-nova of 1907 in Messier 101 (distance= $1{\cdot}3\times10^{6}$ light-years). If the corpuscles be protons, then the energy of the corpuscles reaching the earth now from the Andromeda nova can be calculated (knowing the distance and the time-difference, namely 50 years) and is found to be 0.84×10^{11} volts which corresponds to a penetrating power of about 220 metres of water. The energy of the protons now reaching the earth from M. 101 is calculated to be 1.43×10^{11} volts which corresponds to a penerating power of 360 metres of water. Now Clay's cosmic ray measurements under water in the Gulf of Aden showed a maximum at 235 metres in the ionization curve, just when M. 101 culminated, shewing that there was at this time a corpuscular ray at the end of its range. Zanstra points out that in order that corpuscles from M.101 may be able to penetrate to the depth of 235 metres at the time of its culmination at Aden they must have a range of 330 metres of water which agrees very well with the theoretical value of 360 metres calculated from astronomical data. The cosmic ray measurements of Regener under water in Lake Constance also shew two maxima of ionization at 230·6 metres in each of the two successive periods of 24 hours, a sharp maximum corresponding to this culmination of the Andromeda super-nova and a wide one corresponding to the super-nova in M.101. The range of the rays from the Andromeda nova at the time of its culmaination at Lake Constance should be 240 metres of water which agrees well with the theoretical value of 220 metres. Rays of 330 metres range from M-101 (according to Clay's measurements at Aden) should penetrate 230.6 metres of water in Lake Constance in 10 hours and Zanstra finds that the wide maximum in Regener's ionization curve actually spreads over 10 hours. Zanstra also points out that certain irregularities in the ionization measurements made under different depths of water at Bergen by Clay and 'T Hooft in the summer of 1935 can also be explained, at least qualitatively, as due to the influence of the two above-mentioned super-nova. Thus Baade and Zwicky's hypothesis that super-novae are a source of cosmic radiation acquires a good deal of plausibility, provided of course a part at least of cosmic radiation consists of protons, for Zanstra's conclusions are true only in the case of protons but not of electrons or positrons. It is to be noted however that protons have been found in cosmic rays not as a primary phenomenon, but as a secondary result of interaction of cosmic rays with nuclei (see C. Anderson, *Phys. Rev.* Aug. 1936). In the present confused state of our knowledge all that can be stated is that primary cosmic rays consist mainly of electrons and positrons, but it seems possible that there is an admixture of protons and perhaps also of neutrons. If Blackett's view be true that photons are emitted during the encounter of a primary cosmic ray with matter and are then converted into electron-positron pairs on collision with atomic nuclei, then we have here an actual case of conversion of radiation into matter. According to Jeans and Eddington, our material Universe is inevitably running down; there must be a moment when the entire solid universe will radiate away in a "final broadcast." The only way of escape from this gloomy end is the conversion of radiation back into matter.

* The time-difference is not appreciable if the particles are electrons.

Beri-beri and Mustard Oil

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MUSTARD oil is a clear bright yellow oil expressed from the seeds of Sinapis (or Brassica) nigra and also to a certain extent of Sinapis alba and Sinapis rubra. It is the principal culinary fat used throughout Bengal, Assam, Behar, Orissa, and to a certain extent, eastern U. P. The oil is generally obtained by expression from the seeds by indigenous "Ghannies" or wooden presses driven by bullocks, although in large towns like Calcutta, Cawnpore, Aligarh, etc., there are large power driven machines consisting of grinders and expellers for the manufacture of the oil on a large scale. The market price of the oil varies from Rs. 13 to Rs. 17 per maund.

The composition of mustard oil varies considerably in accordance with its place of origin and the kind and quality of mustard used in its manufacture, but the following may be taken as the representative analysis:

Allylisothiocyanate ..	.. 0.7%
Hydrogen Cyanide ..	.. 0.02%
Free Fatty Acid ..	.. 3.8%
Moisture	.. 1.8%
Glycerides ..	.. 92.2%
Unsaponifiable matter ..	.. 0.8%

The various constants of bazaar mustard oil as determined from time to time in our laboratory are as follows:

Saponification value	172—175
Iodine value ..	105—114
Acid value ..	3—11
Unsaponifiable matter	0.5—1.2
Hehner value ..	91—93

From the above it will be seen that hydrogen cyanide is a normal constituent of ordinary bazaar mustard oil to the extent of about 2 parts in 10000, and is probably entirely harmless in such minute concentrations. When the oil is heated in course of cooking perhaps the entire amount is volatilized. Allylisothiocyanate is the volatile and pungent constituent of mustard oil. The physiology of this compound is not definitely known, but in the concentration in which it exists in mustard oil, it is not expected to be harmful, at least there has been no case on record to this effect. This volatile constituent of mustard oil is entirely volatilized by keeping the oil at 150°C for ten minutes.

Mustard oil is the standard cooking oil in Bengal, and as such it is consumed in enormous quantities. As the quality of mustard oil is generally judged by the pungency of its odour by the lay public, so unscrupulous dealers and manufacturers often take recourse to various adulterations in order to increase the pungency of the oil. Amongst the substances that are added for this purpose, the following may be mentioned:

Rape oil.
Jute seed oil.
Raddish seed oil.
Horse raddish and its oil.
Onion and onion seed oil.
Acrolein.
Allyl bromide.
Bromacetic ester.
Synthetic allylisothiocyanate.
Phenylisothiocyanate.
Carbanile.

Amongst the synthetic compounds mentioned towards the end of the list, many of which are generally incorporated in the so-called "Mustard oil essence" available in the market, bromacetic-ester and allylisothiocyanate are the most powerful, and a comparatively small quantity produces pungency in a large quantity of the oil. As far as it is known, bromacetic ester is comparatively harmless, or at most produces a sedative action

BERI-BERI AND MUSTARD OIL

like most of the alliphatic bromo compounds, but allylisothiocyanate of synthetic origin is definitely dangerous, containing as it does, the highly poisonous allyl cyanide in small proportions, which acts like a metallic cyanide in most respects.

On account of the great prevalence of Beri-beri in the eastern districts of U. P., particularly amongst the Bengalee population in recent years, many investigators have devoted their talent and untiring energy in the illucidation of the cause of the disease. There must be something wrong in the diet of the Bengalees which is causing this particularly legs and weakening eyesight and glaucoma. These symptoms are similar to those produced by cardiac poisons like thevatin, digitoxin, stropanthin, hydrocyanic acid and the cyanides. In fact the symptoms of Beri-beri are so closely akin to cyanide poisoning that the present investigator was inclined to believe that there might be some relationship between the hydrogen cyanide content of bazaar mustard oil and the Beri-beri which is produced in its consumers. With this end in view, the present author took up the analysis of a number of samples of bazaar mustard oil and the results are summarized below:

	Sample No. 5 from a local Store.	Sample No. 11 from Pryag Oil Mill, Aligarh.	Sample No. 23 brought by Dr. Ghosh from Benares.	Sample No. 17 from a local mill.	Sample No. 26 from a village
Saponification value	174	175	180	173	175
Iodine value	105	103	112	110	102
Acid value	3·2	2·1	26·5	21·5	4·2
Unsaponifiable matter	0·6	0·7	2·1	2·4	0·8
Volatile-oil	0·5	0·7	1·6	1·4	0·5
Hydrogen cyanide	0·02	0·02	0·7	0·65	0·03
Allylisothiocyanate	0·45	0·63	0·2	0·15	0·56

insidious disease. The question of vitamin deficiency naturally comes in one's mind, and many physicians have prescribed a full course of substances rich in vitamin B with hardly any improvement of the situation. Some people have accused fish, some eggs, some mustard oil, and some rice for bringing about this disease amongst the Bengalee population, since in respect of these articles of diet the Bengalees differ from the U. P.-wallas. There are many Bengalee families in this province who never take rice at any time, but nevertheless they have been affected. Europeans and Muslims take fish and eggs, but they are more or less immune. So naturally the suspicion of causing Beri-beri falls on mustard oil which is in universal use amongst the Bengalee population.

The usual symptoms of Beri-beri have been variously described in standard literature, and also amongst the recent publications. The most important amongst the symptoms are affections of the heart like palpitation, dilatation, breathlessness, congestion in the extremities of the body

Sample No. 23 (one gallon) was brought by Dr. R. N. Ghosh of the Physics Department from Benares at a time when Beri-beri was raging there in an epidemic form, and he assured the author that whoever took the oil invariably got affected with Beri-beri in a more or less violent form. On account of the large supply available, the determination of hydrogen cyanide in the oil was made with great accuracy and a good quantity of hydrogen cyanide was actually isolated. The technique of estimation of hydrogen cyanide in minute quantities in the oil was also fully developed. The amount of hydrogen cyanide in the oil was found to be about 35 times that usually met with in ordinary mustard oil, and perhaps in a dose sufficiently strong to cause cardiac posioning. Microscopic examination of the oil showed the presence of numerous spores in the liquid, and qualitative examination revealed the presence of some unknown hydrolytic enzyme. Similar observations were also made with sample No. 17. Could the enzyme be originally present in the mustard, which could break up the isothiocyanate into hy

drogen cyanide and other products and also increase the acid value enormously, or is it subsequently formed in the mustard by the agency of a fungoid disease or rust? This is a question which has not yet been answered, and I think an illucidation of this point will considerably clear up the subject which is so much shrouded with mystery.

Summary and conclusion

1. Beri beri or epidemic dropsy appears to be a kind of food poisoning from the symptoms that are manifested in the patients suffering from the disease.

2. The symptoms are closely akin to those of cardiac poison like hydrogen cyanide.

3. Ordinary bazaar mustard oil contains about $0{\cdot}02\%$ of hydrogen cyanide, but in some very bad samples, hydrogen cyanide content of nearly 50 times as much has been detected. Perhaps the constant intake of such oil might produce slow cyanide poisoning.

4. The production of hydrogen cyanide in mustard oil in comparatively large quantitites is apparently due to a hydrolytic enzyme acting on the cyanogenetic glucoside present in mustard. The enzyme is perhaps produced in the mustard as the result of a fungoid disease or rust.

The Heavy Electron

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IN all scientific work, there is a tendency to regard that the fundamental Laws of Nature should be essentially simple. Thus from the earliest times, people believed that the great diversity of substance in the universe was only apparent. They believed that the different substances were formed out of a few elementary ones. Researches in chemistry in the beginning of the nineteenth century appeared to establish that all substances were made up from a number of elements, which number was later fixed at 92. But even 92 were considered too many and efforts were made to prove that the so called elements were formed out of still simpler constituents. With the discovery of the electron in 1895, and of its ubiquitous occurrence, scientists speculated that elementary +ve and −ve charges were the ultimate constituents of all matter. But up to 1930, no positively charged particle lighter than that of the hydrogen atom, which is 1840 times heavier than the electron, had been found. The atomic nuclei of different elements were considered as made up of protons and electrons, but closer investigations revealed difficulties and have led to the discovery of other fundamental particles besides the proton and the electron.

What is a Fundamental Particle?

It might be asked as to exactly what is meant by fundamental particles. We may repeat the old saying that it is one which is not further divisible. Besides this the characteristics of the fundamental particles are given by its electrical charge, mass, mechanical moment, magnetic moment and the statistics it obeys (either Bose-Einstein or Fermi-Dirac statistics).

For illustration we may take the most well-known fundamental particle, *viz.* the electron. It has got

A negative charge of $e = 4{\cdot}80 \times 10^{-1}$ e.s.u.
A rest mass of $m = 9{\cdot}035 \times 10^{-23}$ gms
A spin moment of s $\frac{1}{2} h/2\pi$ (h = $6{\cdot}55 \times 10^{-27}$ erg × sec)

A magnetic moment of $eh/4\pi cm$ called a Bohr magneton and it obeys the Fermi-Dirac Statistics.

THE HEAVY ELECTRON

" Statistics ' means the way in which particles herd together and experience has shown that elementary particles herd together in two distinct ways. A geometrical point can have three degrees of freedom, all of translation, but all elementary particles have been found besides translation to possess a further degree of freedom which is called the spin and which is somewhat vaguely connected with rotational motion of the particle about itself. According to Fermi-Dirac statistics, no two particles belonging to the same system can have all their degrees of freedom (ways of motion) identical. But in the Bose-Einstein statistics this prohibition does not exist. The origin of the two kinds of statistics is best explained by the wave theory of matter.

A half integral spin is associated with the Fermi-Dirac statistics and a zero or integral spin with the Bose-Einstein statistics.

Discovery of the Neutron and the Positron

Up to 1932, only two fundamental particles were known, *the electron and the proton*. Two more fundamental particles have been definitely established since 1932. They are the neutron and the positron. Chadwick discovered the neutron first from several indirect evidences. He proceeded from the observation of Bothe and Becke that if Be is bombarded with α-particles from polonium, we obtain not only γ-radiation but in addition a very penetrating type of radiation of entirely different properties. These radiations leave no track in the Wilson-chamber (see SCIENCE AND CULTURE, *I*, pp. 12-19) except when they come into contact with nuclei; when they pass through substances containing hydrogen (*e.g.*, paraffin), high velocity protons are emitted. If the radiations are photons and the protons are emitted due to Compton effect, the radiation should have an energy of 55 mev, which is greater than the energy-balance allowed for in this reaction. Moreover the proton-tracks are a thousand times greater in frequency than expected from Compton effect, though there is no trace of photo-electrons. All this contradictory evidence can best be explained on the hypothesis that the new particle has no charge and a mass approximately equal to that of the proton. A more accurate determination of its mass is made from a very interesting experiment. When γ-rays from ThC″ having the energy of 2·6 mev is allowed to fall on the deuteron nucleus it is found to break up into a proton and a neutron. The same experiment when made with γ-rays from RaC″ having the energy of 1·81 mev does not show any evidence of the deuteron nucleus breaking up into a neutron and a proton. This gives us the exact mass of the neutron within very narrow limits to be 1·0091. Since the spin of the deuteron has been found to be 1, that of the neutron must be $\frac{1}{2}$ or $\frac{3}{2}$. We represent the deuteron as made up of a neutron and a proton in the following way.

$$D = n + p.$$

' *D* ' means deuteron, *n*—neutron *p*—proton

The spin being a vector quantity,

$1 = \left|\frac{1}{2} + \frac{1}{2}\right|$ or $\left|\frac{3}{2} - \frac{1}{2}\right|$ for parallel or antiparallel spins.

The magnetic moment of the neutron is negative and about ·75 proton units, ($\mu_p = eh/4\pi cM$).

The second discovery was that of the positron by C. D. Anderson of the California Institute of Technology. He developed a method originally due to Skobelzyn, a Russian worker, of photographing the tracks of the cosmic rays in a Wilson chamber which is placed in a strong magnetic field. The arrangement is automatic so that as soon as a cosmic ray enters the chamber, certain automatic releases are set free, whereby the magnetic field is switched on and the Wilson space expands, and the tracks of the particles set free are photographed in the camera which is also exposed by the same mechanism. In these photographs, Anderson noticed a new type of track whose curvature corresponded to that of positive particles. But the track was not heavy as we get for the proton but consisted of dots, as swift electrons show. But a positive electron was unthinkable though Dirac from theoretical considerations, had vaguely predicted it. To definitely establish that it was not an electron moving in the opposite direction, Anderson kept a plate of lead within the Wilson chamber and the direction of motion of the particle was given from the direction

of less curvature to that of greater curvature. This definitely established the existence of 'positrons' or particles having the same mass as that of the electron but with a charge of opposite sign. Later nuclear reactions involving positron emission were discovered. The spin of the positron is half integral and it obeys Fermi-Dirac statistics. With the discovery of the positron it appeared that it was no longer necessary to regard both the neutron and the positron as elementary, for one of them may be regarded as made up of the other as follows:—

$$n^1_0 \rightarrow p^1_1 + e^0_{-1} \quad ; \quad p^1_1 \rightarrow n^1_0 + e^0_{+1}$$

Where e^0_{-1} represents an electron and e^0_{+1} a positron. The masses of the neutron and proton are 1.0091 and 1.0081 respectively, and that of the electrons in the same units is .00054, which is possibly the mass of the positron also. The first reaction is impossible since $1.0091 > 1.0081 + .00054$. The second reaction gives a far too greater binding energy for the proton state which means a large energy is needed for the disintegration of the proton into the neutron and electron. The other difficulty is that of spin and of magnetic moment which ought to be conserved, but as the spins of all the three particles are half integral, this is impossible.

The β-ray Disintegration and the Neutrino Hypothesis

Similar difficulties and others of a more fundamental nature were met with in another phenomenon. This is the phenomenon of the nuclear β-ray disintegration where β-rays or high velocity electrons are emitted from the nucleus of an element. The examination of the β-ray spectrum (that is the distribution of energy of the electrons) gives us the fact that the β-rays emitted by a radioactive nucleus have not definite value of energy as in the case of α-rays, but varies in general from a small value to a maximum. This would in general mean that the product nuclei have varying energies. For example RaE (mass No. 210 atomic number 83) emits β-rays and is converted to RaF (mass No. 210, atomic No. 84). As both RaE and RaF are definite chemical entities, the law of conservation of energy demands that the β-rays should be emitted with the same energy. But it is found that the energy of the β-ray is spread out in the form of a spectrum from about 30000 volts to million volts.

A second difficulty is that of spin. The electron has a spin $\frac{1}{2}$ so that if the β-radioactive nucleus has an integral spin, the product nucleus should have a half integral spin. This contradicts our general experience that particles having the same mass number have the same spin. For an explanation of these two anomalies one has two alternatives.

(1) That the law of conservation of energy and spin breaks down for the nuclear β-particles; or

(2) Another fundamental particle is emitted which has a half integral spin, and carries away a part of the energy of the reaction so as to restore the balance of energy and spin. The particle has no charge and a very small but variable mass. This second suggestion was made by Pauli and he called the hypothetical particles **neutrino.** Fermi worked out on this hypothesis the probability of β emission from the nucleus by the conversion ($n^1_0 \rightarrow p^1_1 + e^0_{-1} + \nu^0_0$)[$\nu$ denotes Neutrino—the process indicates a neutron changing into a proton, an electron and a neutrino] and found that he could give an explanation of the emission curve of the β-rays. The neutrino hypothesis seems necessary if we do not wish to face the breakdown of the conservation laws but we cannot accept existence of particles unless they can be actually demonstrated. Nahmias thought that the neutrino might have a magnetic moment so that in its passage through matter a small number of ions will be produced. Bethe showed that if the magnetic moment of the neutrino $= n$ Bohr magnetons, the number of ions it will produce is $10^3 \times n^2$ per km of air. Nahmias on this basis tried to obtain evidences of ions by using no less than 5 grams of Radium and using Geiger-Müller counters to detect ions. The counts obtained in the counters, however, could not be attributed to neutrinos as the number of counts obtained were larger than expected from the neutrino hypothesis. Lejpunskij made an attempt to detect the neutrino from another direction. He argued that since the neutrino has a finite mass, though small, it will, when ejected from a nucleus,

cause the nucleus to recoil owing to conservation of momentum. He made attempts to find the recoil track of the nucleus in a Wilson-chamber. He could, however, find no definite evidence in favour of the ne

The Heavy or the Bose-Electron?

So far we have dealt with five fundamental particles, the electron, the proton, the neutron, the the positron and the hypothetical neutrino. All these particles have spin $\frac{1}{2}$ and obey F-D statistics. But wave-mechanics tells us that particles can also obey B-E statistics. So far photons, deuterons and a number of atomic nuclei have been found to obey B E statistics. But the deuteron and other atomic nuclei are not elementary and the photon is not a mass-particle. We can well ask whether there can be any other elementary mass particles obeying the B.-E statistics. For example, can we imagine an electron obeying B-E stastistics, and called for the sake of shortness a *Bose-electron;* such an electron, if it exists, cannot occur in the extra-nuclear orbits of an atom but will immediately fall into the nucleus.

Stueckelberg on this hypothesis made the interesting suggestion that the emission of a β-particle is really a two-stage process. The Fermi theory of the proton-neutron interaction within the nucleus can be extended in the following way $p^1{}_1 \rightleftharpoons n^1{}_0 + e^+_B$ (I) and in the β emission that follows, the Bose-electron transits as

$$e_B \longrightarrow e^+_F + \nu^0_0 . \quad \text{(II)}$$

It will be noticed that the interaction-energy is due to the Bose-electron and not the Fermi-electron in this theory.

In the processes mentioned above there is no difficulty about the spin. The probability of the spontaneous transitions (I) and (II) has been calculated by Stueckelberg. He finds that such transition can occur provided a transition occurs in the opposite direction simultaneously. A calculation of β^{-ve} and β^{+ve} emissions on this basis give a smaller probability of such transitions than in the Fermi theory, which conforms more to the facts of β emission.

From a knowledge of the interaction energies involved in the reactions (I & II), it is possible to form an estimate of the mass of the Bose-electron, which Stueckelberg estimates from the reactions as greater than 24 times the mass of the ordinary electron. Because of this large mass it may be called *a heavy electron.*

It may be mentioned that in 1935, a Japanese worker, Yukawa, suggested the existence of the heavy electron in a paper dealing with the interactions of elementary particles within a nucleus. The actual interaction energy in disintegration is much larger than that warranted by the exchange of an ordinary electron, *i.e.*, if we suppose the reaction is, $n^1{}_0 \rightarrow p + e_F^{-ve} + \nu^0_0$. Yukawa assumes a hypothetical particle of mass m' to get the correct interaction energy between the neutron and the proton and m^1 he finds to be $\simeq 50mc^2$. On the hypothesis of an integral spin Yukawa explains the small probability of disintegration among most nuclei. His calculations are comparable with Stueckelberg's and his mass for the heavy electron compares favourably with that of Stueckelberg's value.

The Heavy Electron in Wilson Chamber

So far the Bose-electron has been a matter of speculation and no experimental evidence has been

Pike's Peak, 7900 gauss. A disintegration produced by a nonionizing ray occurs at a point in the 0.35 cm lead plate, from which six particles are ejected. One of the particles (strongly ionizing) ejected nearly vertically upward has the range of a 1.5 MEV proton. Its energy (given by its range) corresponds to an $H\rho = 1.7 \times 10^6$, or a radius of 20 cm, which is three times the observed value. If the observed curvature were produced entirely by magnetic deflection it would be necessary to conclude that this track represents a massive particle with an e/m much greater than that of a proton or any other known nucleus.

found which could testify to its actual existence. The difficulties seem to consist in the fact that the

heavy electron does not occur freely in Nature, and cannot be a constituent of the outer shell of atoms.

Recently, however, interesting evidences have been found by Neddermayer and Anderson and Street and Stevenson which seem to point to the actual existence of the heavy electrons.

Neddermayer and Anderson performed experiments with high energy cosmic ray particles to test the Bethe-Heitler theory that ΔE, the loss in energy in passage through matter of charged particles, is proportional to the incident energy E of the charged particle. They kept a slab of platinum 1cm thick inside Wilson-chamber in a magnetic field. The particles ejected by cosmic rays from the nuclei of matter seemed to separate into two groups, one type was found to be more penetrating than the other. That is, more energy is lost by one set of particles in passing through matter than by the other set. The tracks of these more penetrating particles were definitely not those of heavy particles like the proton and α-particle but were intermediate between these and the tracks of electrons.

The two hypothesis that could account for the separation into two groups were:—

(*i*) The particles are not of the same nature so that ΔE is not proportional to E due to the essential dissimilarity of the incident particles; or

(*ii*) The Bethe-Heitler law does not hold good for high energy particles.

The second postulate is untenable as it has been found that the Bethe-Heitler law does hold good for electrons and positrons of energies up to 400 mev, and the anomalies found occur for energy sometimes of 400 mev but mostly at 500 mev and greater. (mev denotes million electron volts).

We are thus left with the first hypothesis that the particles are of two types. The first type is the ordinary electrons and positrons, the second type of particles show ionisation tracks which are neither proton-tracks nor electron tracks. On the assumption that they are protons, (for $H\rho = 4{\cdot}5 \times 10^5$ gauss $\times$cm as is found for some of these tracks), the ionsation should be 25 times as much as observed in the photographic plate. It is thus definite that the tracks are not those of protons. What are then these particles? We get some idea about them from the absorption factor; for charged particles, this varies as the square of the charge and inversely as the mass. To explain the greater penetration of these particles, it suffices to assume a mass greater than the electron or a charge less than that of the electron. The former is the more commendable hypothesis as assuming a different charge would give rise to other inconsistencies in explaining the nature of the ionsation tracks. From the evidence of the curvature we get an estimate of e/m. From this, the rest mass is estimated at about 50 times the mass of the ordinary electron. Yukawa, as we mentioned before, gave almost the same mass for his hypothetical *Bose-electron.* These heavy electrons have been so far found only in cosmic ray showers and have not yet been detected in ordinary matter. Yukawa suggests that this should be so; for the Bose electron, even if it exists, should do so only in atomic nuclei. This suggests that the heavy electrons obey the Bose-Einstein statistics rather than the Fermi-Dirac statistics.

There are many interesting speculations regarding the nature of the Bose electron or the heavy electron. It seems as already mentioned that the Bose-electron does not exist as an extra-nuclear electron. If, as Yukawa has suggested, the heavy electron exists as a nuclear particle the difficulties regarding spin in several nuclei can be easily explained. It also explains the neutron-proton interaction better than the older theory. Stueckelberg has compared the photon with the Bose-electron. Its emission and absorption would, according to Stueckelberg, be similar to that of photons subject to the law of conservation of electron charge.*

* I thank my teachers, Prof M. N. Saha and Mr. R. N. Rai for their valuable advice and suggestions in the preparation of this article. —B. D. N. C.

A Critique of the New Ideas on Examination

(Continued from the last issue)

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Assessing the Value of Mental Tests

The tone of high optimism in regard to the new type of examination and many reports of their success, prompted a number of psychologists in different countries to investigate the issues more closely. I shall try to present a brief survey of the data so far as I have been able to gather them.

Correlation between the data of mental tests, the award at interview and old type of examination.—Magson[10] finds that the (*i*) "interview estimates," (*ii*) mature estimates upon prolonged acquaintance and (*iii*) estimates of "quickness and profoundness of apprehension" give a coefficient of correlation of only ·25. The figure is too low to have any significance.

Unsatisfactory character of interview as a method of selection and estimation of intelligence.—As a matter of fact, interview is essentially an unsatisfactory and probably an unfair method of selection. Magson gives the following reasons for the low correlation:

(*a*) The questions and answers cover too small a part of the candidates' mental contents. (*b*) The same questions are not often put to all the subjects. (*c*) Many of the topics are controversial and it is difficult for the judge, on the spur of the moment, to assess fairly an opinion contrary to his own. (*d*) The candidate is usually in a state of emotional tension. (*e*) Appearance and manner play a larger part in determining valuation than is usually realised by the judges.

On this last point it would be interesting to note the view of Binet, the pioneer of mental testing; "In this connection I noticed a surprising fact: to one of the questions two pupils made exactly the same reply, but one received a better mark than the other entirely because the interview had the idea, which he confessed to me, that this pupil was more intelligent than the other."[11]

Again, in 1923, in one of the Western countries of England, all the candidates for a *minor scholarship examination* were subjected to an interview in addition to the regular examination. The following correlations were obtained between the interview grades and the result of the examinations.[12]

TABLE 3.

Correlation between Interview and Examinations.

5 Boys' School	·42, ·35, ·21, 14, ·27.
7 Girls' School.	·47, ·30, ·45, 22, 61, 03, ·10.
9 Mixed School.	·48, ·31, ·30, ·16, ·16, ·12, 11, ·15, ·19.

The facts quoted above clearly indicate that interview is not a satisfactory method for estimating a person's general ability or intelligence. Yet this method is much in vogue both in the sphere of academic and of vocational selection. Another set of facts quoted from the work of the same author would show the unsoundness of this procedure.

TABLE 4.[13]

Correlation between Interview and the mental tests applied to six groups of persons.

Groups	I	II	III	IV	V	VI
	·08	·16	·29	·40	·16	·06

10. Magson, *How we judge Intelligence.* Thesis accepted for the degree of D.Sc. at London, Cambridge University Press, 1926.

11. Binet, *L'Année psychologique*, Vol. XVII.

12. Magson, *Op. cit.* p. 101-2.

13. Magson, *Op. cit.* p. 90.

The conclusion to be drawn from these figures is that if interview be regarded as reliable, the mental tests should be adjudged to be unreliable and vice versa.

This criticism applies to the method of interview if we look upon it as procedure for measuring intelligence or general ability. It is frequently used, however, as a measure of a quality different from intelligence. For instance, it is said to give us a measure of (*i*) a person's '*presentableness*,' (*ii*) his '*social adaptability*' and (*iii*) of his '*general tact and demeanour.*' The criticism does not apply to such uses of interview. The difficulty, that the terms mentioned above are not definable or easily measurable, cannot, however be surmounted.

The value of Intelligence Test scores as measures of probable scholastic success.—The value of intelligence test scores is not higher when we look upon them as indicators of probable academic success. Oddell[14] calculated the coefficients of correlation between college marks, high school marks and intelligence scores. The values of the coefficients range between ·20 to ·50. The correspondence is not high enough. Edds and MacCall[15] worked out correlations between (*a*) Otis group intelligence test scores, (*b*) Cross English test scores, (*c*) high school grades and college marks. The high school marks have higher correlation than the other scores.

Wagner[16] reviews the data of studies in correlation between the various measures of scholastic achievement at the college and (1) High school averages (2) Intelligence tests comprising the Army Alpha, Terman and Otis. He comes to the conclusion that the high school average is on the whole superior to the mental tests with respect to their predictive value. Kellogg[17] attempts to determine the relative values of intelligence tests and matriculation marks as ways of estimating probable success in college. He discusses the problem with reference to a group of students who took the introductory course in psychology at McGill University, Canada, in 1926-27. The following coefficients of correlation are significant: (1) The correlations between the matriculation marks and those gained at the end of the Freshman Year is .747. (ii) The correlation between the Army Alpha test scores and the Thurstone Psychological examination for College students' scores was only .173. (iii) Between the intelligence test scores and the marks of the Sophomore and Junior years there was a higher correlation.

This view in regard to the intelligence tests as substitutes for entrance examinations is not confined to the workers in the United States and Canada. It is shared by many competent authorities on the continent also. I shall present only three more studies in support of the view mentioned above. Dietz[18] on the basis of a careful study concludes: "Intelligence tests are inadequate as sole basis for selection." Sterzinger[19] in Vienna calculates the correlation between certain mental tests and school marks. The following table gives his results:

TABLE 5.

Correlation between school marks and certain mental tests.

(1)	School marks and simple cancellation	·27
(2)	„ „ „ complex „	·37
(3)	„ „ „ rote memory	·21
(4)	„ „ „ logical memory	·34
(5)	„ „ „ sentence building	·42

14. Oddell, Predicting scholastic success of College students. *University of Illinois Bulletin* No. 5.

15. Edds and MacCall, Predicting the scholastic success of College Freshmen. *Journal of Educational Research* 1933 No. 27, p. 127-130.

16. Wagner, A survey of literature on College performance prediction. *University of Buffalo Studies* 1934, No. 9, p. 194-209.

17. Kellogg, C. E., Relative values of Intelligence tests and matriculation examination as means of estimating probable success in College. *School and Society*, 1929, No. 30, p. 893-896.

18. Dietz, Selection des élèves de l'enseignment Secondaire. Recherches de statistique Mathematique et de psychologie experimentale. Thesis submitted to the faculty of science, University of Paris, 1934.

19. Sterzinger, Untersuchungen über die Aufnahmeprüfung in die Mittelschulen *Vjsch. für. jugenkundt* 1931 No. p. 21-37.

All the correlations are of small value and cannot form the basis either of selection or of prediction.

Lommatzsch[20] puts himself the question "Are entrance examination intelligence tests best forecasters of academic achievements?" The data were obtained from a school for girls in Dresden. The ranks of students at the time of admission in particular subjects and at the end of the first school year were compared. The correspondence was just as close when the intelligence data were not considered as when they were. The author raises the question whether from the point of view of economy mental tests in this field are worth the trouble that they demand.

These conclusions should not cause surprise to a psychologist. (*i*) The mental tests were formulated for the purpose of ***elimination*** of children who failed to exhibit a minimum standard of ability. It was ***not intended*** by Binet and Simon as a measure of success. (*ii*) Again, the mental test scores cannot from the nature of the assumptions implicit in the tests, reflect the ***various grades of ability*** beyond the threshold of success. We may put the idea in another form:

We can have, to use a present-day favourite term in psychology, the different type of ***ability-profiles*** corresponding to the low scores; we can form no graduated scale of such profiles corresponding to the higher values of intelligence-quotient. (*iii*) The ***tests arc formulated to adjudge person's capacity to adapt themselves to things of the usual environment.*** They are not calculated to bring into relief the specific aptitudes which the specialised studies of modern academic life demand. These seem to me to be the principal reasons for the discrepancy of results to which I have drawn attention.

The psychological examinations.—The third substitute of traditional method of examination, the psychological examination, the basic principles of which have already been discussed, remains to be considered. The report on this is somewhat better than that on mental tests. Corey[21] finds that the reliability coefficient of the new type of examination is .82. In the essay type of examination it is only .58. (Reliability coefficient is the coefficient of correlation between the marks awarded to the same pupil on the basis of same work by several examiners). Thus it subserves one of the purposes for which it is formulated.

As an index of a student's probably success at the university, the psychological examination seems to have a certain value although its predictive significance is not very high. Here again, the percentage of correlation differs in the case of different tests. It is found that Co-operative English test has a coefficient of ·66 with the first year's examination at the College. The American Council psychological examination has a smaller value[22].

Again, Wagner to whose work reference has already been made, finds that the College Entrance Board aptitudes test, the Ohio State University tests, the Thorndike tests and the American Council psychological examination have less predictive significance than the high school average. Freeman presents the data of a study based on the application of the American Council psychological examination. The correlations are generally low. Yet those who score high in the tests usually do well in the college. The author concludes, "But it must be admitted that marked as this tendency is, it is not sufficiently marked to warrant the exclusion of a student." The test should be used mainly as a source of supplementary information[23].

The tests and psychological examinations, then, cannot in the present condition of our knowledge be readily employed in lieu of the traditional method of examination for the purpose of selec-

20. Lommatzsch, Zur Frage der Intelligenz Prufungen. *Höhere schule in Sachsen* 1929 No. 7. p. 345-347.

21. Corey, New Type and Essay Examination scores. *School and Society* 1930 No. 32. p. 849-850.

22. Glatfeter, The value of co-operative English test in predicting success in College, *School and Society*, 1930, No. 44, p. 383-384.

23. Freeman, Predicting Academic Survival. *Journal of Educational Research* 1931 No. 23, p. 113-123.

tion. Even if we desire to use them for "supplementary" information, a great deal has to be done before we can resolve our plan into practice.

The Legitimate uses of Mental Tests

The considerations to which I have referred above should not lead one to the conclusion that mental tests and psychological examinations are useless contrivances set up by psychologists. The point of my argument is that *they should not at the present stage of our knowledge, be adopted as the only or as the main basis of selection and prediction for academic purposes.*

They can, however, be employed very effectively for a number of educational ends.

(*i*) *As instruments of educational control.*—(*a*) They can and should be employed in schools for estimating the progress made in particular subjects. (*b*) They can also be used for determining the relative efficiency of different methods of teaching.

(*ii*) *For the discovery of the backward and the ament.*—The original purpose of the mental tests was to discover those who cannot profit by a course of training in the ordinary schools. It is possible to single out these individuals, because their bodily and mental reactions differ in definite ways from those of normal persons. Mental tests can always be used for the detection of those who fall short of the standard of efficiency of a particular type in a given group.

(*iii*) *For the discovery of special aptitudes.*—The tests and examinations though they may prove inconclusive when they are made to suit a complex of aptitudes or a large number of variable abilities, are of great value for the purpose of discerning specific abilities. Thus we may test steadiness of attention, quickness of motor responses, capacity to bring to bear a complex set of instructions on a particular problem and various other abilities.

Suggestions

Uses of mental tests and psychological examinations on our educational system.—The trend of education in the West indicates that sooner or later mental testing will be regarded as an important instrument for (*i*) the regulation studies in school, and (*ii*) for the discovery of special aptitudes in scholarship. (*iii*) It will also be more in use in India (*a*) for the discovery of the backward children who are usually drags on the class and have to be paid special attention; and (*b*) for the singling out of exceptional children who may, with appropriate aid, make speedier progress. (*iv*) A regular programme of testing is likely to reveal the proper methods of instruction in several subjects. For, the mental tests and psychological examinations break up the process of instruction and acquisition into simpler units. The detection of the source of difficulty of the teacher as well as of the pupil becomes easy in this way. (*v*) We must not lose sight of the most important function of these tests. The vocational aptitudes of pupils can only be judged on the basis of *a series of tests* applied from the age of puberty till two years after that age. The interests of pupils in this matter are notoriously unstable. Often a choice is made without an adequate knowledge of the conditions of the vocations selected. It is essential, therefore, that the fleeting inclinations of these growing years should be seized upon by tests. We can then determine on the basis of these changing patterns of interests those that abide and correspond to the realities of the vocational situation.

(*vi*) I must refer to another line of work in this connection which has been of use in the West. It has been found that manual skill depends upon a large number of factors.[24] It is necessary to understand how far in the preadolescent years these determining tedencies can be developed through training. Analysis of these factors, then, is the first requisite.

(*vii*) A similar line of research is suggested by the numerous studies on the character of mechanical aptitudes.[25] It is also found that there is

24. Wallon, H., L'habilité manuelle, *Revue de la science du travail*, 1929, No. 1. p. 217 232.

Gemelli, Recherches sur les diagnostic de l'habilité motrice *Op cit.* p. 181-197.

25. Earle, Macrae and others, A test of mechanical Aptitudes. Nat Inst. Psych. 1929. *Reprint* No. 3, p. 42.

a high degree of correlation between the capacity of space discrimination and perception of forms. It is a problem for investigation whether the development of the last mentioned capacity leads to the development of the others.

There are numerous problems of the same type which require solution if the aptitudes of students for scholastic and vocational careers are to be adequately measured. This, however, needs the setting up of special laboratories for the purpose. I turn to the formulation of this suggestion.

Setting up a Laboratory

The formulation of tests and analysis of capacities require prolonged research. I suggest that laboratories with adequate equipment be set up at various university centres in India to carry through the different lines of work suggested above. The cost need not be very high in the beginning. It may be spead over five years at the end of which the laboratory will be in the full working order. A number of promising students may be awarded fellowships to work in the laboratory and to do some amout of field-work in connection with vocational tests.

I desire to emphasize the view that the mental tests that abound in the West are not readily applicable to the Indian conditions. A mere translation from a European language to an Indian language is not likely to yield any result of significance. It will be necessary to reformulate and re-standardise them. Prolonged laboratory work is, therefore, indispensible.

1250 KV. Generator for Cavendish Laboratory.

This Cambridge, England, laboratory has recently been supplied with a generator capable of producing continuous voltage. It is to be distinguished from an impulse generator, which can only deliver the full power at intervals which last some millionths of a second. The equipment is of the cascade type, in which the well known principle of voltage multiplication through several stages by means of valves and condensers is employed. To ensure the necessary low voltage drop and small heating energy of the filament in the high tension rectifier, gas filled rectifying valves are used. The filaments of these valves are heated by a small high frequency generator, which passes current through the series of high tension condensers and also through small coils which are arranged between and in series with the condensers. The output of the generator is 5 KW., *i.e.*, 4 milliamperes at a constant tension of 1250 KV. and there are 12 stages which operate at a frequency of 200 cycles. The voltage drop of the plant is 40 KV. at 2 milliamperes. The equipment is to be used for the experimental work on transmutation.

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Size and Longevity in Plants

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Size

THE highest mountain peak, the longest river, the largest water-fall and the biggest planet, are matters of interest even to the layman.

The tremendous range of size exhibited by plants is perhaps not so well realized as it should be. On the one hand, there are the bacteria and several lower plants, which cannot be seen at all without the microscope. Some of the former are so small that 50,000 of them would have to be placed in a line to make an inch! Even among the flowering plants, species belonging to the genus *Wolffia*, so common in our pools and puddles, are no larger than pinheads. Roots are absent and the flowers are too small to be seen without the aid of powerful lens.

On the other hand, there are the *Eucalyptus* trees of Australia and the *Sequoias* of California, which may well be called the prides of the forest.

The Amazon Water Lily[1] *(Victoria regia)*, first discovered in 1801 in the waters of the Amazon and its tributaries, has now begun to be very popu lar in cultivation. Its round floating leaves, with the margins turned up about 2″ high, grow at the rate of about 1″ per hour and in favourable cir- cumstances they may attain a diameter of 6-7 feet. They are so strong that small boys or slim ladies can throw on a thin board to distribute the weight, sit upon it, cut off the leaf-stalk and paddle around as if in a boat! The fully open flowers are 8 16″ in diameter and exhale a delici- ous fragrance, somewhat like that of pine-apple. Picture postcards showing a child sitting on one of the leaves of a *Victoria regia* are very popular and can be had at a very moderate price at the entrance to most of the botanical gardens of Europe.

Not less striking is the flower of *Rafflesia Tuan-Mudae*, a remarkable parasite, native of Sumatra. The plant has neither stem nor leaves, but consists merely of a gigantic flower whose stalk is stuck into the trunk of some tree from which it derives its nourishment. The open flower, which is dull-red in colour with yellowish white spots, measures 3 feet in diameter and weighs more than 7 seers! It has an offensive odour like that putrid meat and attracts numerous flies, which are supposed to be respon- sible for its pollination. Accurate information on the mode of distribution of its seeds is not avail- able, but it is said that the fruits are accidentally trampled upon by wandering elephants, pigs and other animals and the seeds which adhere to their feet are rubbed off against the projecting horizon- tal roots of other trees. Here they germinate, promptly establishing contact with the host to enable them to draw upon its reserves for their own growth.

These are both interesting examples of leaf and flower size, but it is among the trees that we must look for real giganticism. The first to attract attention is our own *banyan* tree *(Ficus-benghalensis)*, which is common in every village and affords a welcome shade to man and beast alike. The specimen in the Royal Botanical Gar dens, Calcutta, is specially famous for its size. Eighty-nine feet in height and with 600 aerial roots actually rooted in the ground, its canopy gives the appearance of a small forest rather than a single tree. In 1913 the main trunk was unfortu- nately attacked by a fungus, which quickly spread over many of its branches. The diseased parts were promptly removed but this has left a gap- ing void in the centre of the trunk and weakened the tree to such an extent that it is doubtful

1. This is really not a "lily" at all but a member of the lotus family (*Nymphaceae*), to which also belongs the familiar "*kamal*" of Hindi and Sanskrit writers.

whether it will live very long now. Every effort has, however, been made to prevent it from a senile decay.

The Big Tree of Tule *(Taxodium mucronatum)* must be mentioned in any account dealing with the size of plants. It stands in the churchyard of Santa Maria del Tule, 250 miles south-east of the City of Mexico. Prof. C. J. Chamberlain (retired Professor of Botany at the University of Chicago and an eminent authority on Gymnosperms) gives a particularly vivid description *(School Sci. & Maths.* 1921):-- " More majestic proportions would be hard to imagine, for the trunk is 50 ft. in diameter and a regiment of soldiers could rest in its shade. Twenty-eight people, with outstretched arms and with fingertips touching, can just reach around the trunk!!

Height

Information on the heights of trees is unfortunately not very reliable. Many of the records are the results of a mere ocular estimate or guesswork. It has been claimed that some Australian Eucalyptus trees reach a height of 450-500 feet. Mr. H. D. Tiemann of the U. S. Forest Service, who spent some time in Australia and has made a critical study of the question, says *(Jour. Forestry,* 1935) that there are hardly any specimens that exceed 300 feet in height, and that " as the optimum growth of these trees coincides with the civilized inhabited regions in Australia, likelihood now of finding some as yet undiscovered tree (which is taller) is small."

The " redwoods " *(Sequoia)* of California enjoy the reputation of being the largest and tallest trees in the world. In the Calaveras Grove in southern California a house has been built on the top of a polished stump which is 27 ft. in diameter! A specimen in the Yosemite National Park, popularly called the " Grizzly Giant " is about 30 ft. in diameter and 204 ft. in height. A gateway cut through the base is large enough to permit automobiles to pass through it! Another, in the Humboldt State Redwood Park, is 364 ft. in height and may well be the tallest living thing in the world.

Age

Among animals the tortoise is said to live longest (400 years?), some Greenland whales come second (300 years?), and the third place probably goes to the elephant (200 years?, in captivity). Leaving these, it is probable that man is the longest lived of all animals. There are several undoubted records of persons attaining an age of a hundred years, some of 120-130 years even; but newspaper reports such as we sometimes read of women living up to 140 or 150 years are not all quite reliable. They must be checked by an examination of the following data: (1) Date of birth, (2) Date of death, (3) Proof that it is one and the same person whose records are being examined.

Among plants most of the weeds that we see around us develop, reproduce, and die within a period of about 4 months. Others like the beet *(Beta vulgaris),* require two seasons to complete their life history. Still others, called perennials, live year after year and often attain a very long age.

How to estimate the age of a tree is a question that is frequently asked. In all woody plants an increase in thickness takes place by the activity of a meristematic layer or cambium, which gives rise to new wood cells (xylem) towards its inside and thereby adds to the girth of the roots and stem. In temperate and cold climates the cells of the wood formed in spring are much broader than those formed in summer. In autumn very few new cells are formed and in winter none at all, since the cambium becomes dormant under conditions of low temperature. It thus happens that the summer wood of one year (say 1936) adjoins with the spring wood of the following year (1937), and there is a sharp line of demarcation between the two, which is visible even to the naked eye. To determine the age of a tree, one must cut it at the base and count the number of such lines. This will give the approximate number of summers (or years) which it has passed through.

A stump of a *deodar* tree *(Cedrus deodara)* 704 years old, with one of the cut ends polished and a number of events of historical importance *(e.g.,* erection of the Kutub Minar, accession of Allaud

din Khilii, reign of Mohammad Tughlak, invasion of Timur, accession of Akbar, invasion of Nadir Shah, etc.) which it has witnessed, written upon in bold letters, lies in the museum of the Forest Research Institute, Dehradun.

No one would, however, allow a valuable tree to be felled merely for the curiosity of knowing its age. We can therefore make only rough estimates. A branch of the Big Tree of Tule, which was less than 5 feet in diameter, showed about 200 rings on a radius of 12 inches. The tree itself, which has a radius of 25 feet at the base, should therefore be about 5,000 years old.

With the help of a similar calculation the age of some of the Sequoias has been estimated to be 4,000 years.

A higher estimate has been made in the case of the famous "Dragon Tree" *(Dracaena)* of Oratavia, in Teneriffe, which is said to have been a flourishing tree when the Canaries were first explored by the Europeans in the 15th Century. The traveller, Alexander Humboldt, who visited it towards the end of the 18th Century, describes it as having a girth of about 50 feet and a height of 75 ft. From the cuts and cracks on the bark exuded a dark red resin, which gave the tree its name. Humboldt estimated its age as 5-6,000 years but it is impossible to be sure of this, since the *Dracaenas* do not show any annual rings. Unfortunately the tree was destroyed by a storm in 1868.

In warmer regions, where the winter is not too cold, an increase in thickness of the stem continues throughout the year and the wood of one season is not sharply marked off from the other. In such cases also, it is impossible to estimate the age of the tree, and we can only fall back upon actual historical records, if there are any. Of great interest in this respect is the bodhi tree growing in Anuradhapur (Ceylon). This was grown from a branch taken in 250 B. C. from the famous tree under which Gautama attained his Buddhahood. It is still healthy and its age, 2,187 years, cannot be doubted.

It is perhaps pertinent to refer here to the stories about the germination of Egyptian mummy wheat, 6000 years old. A German professor, who was anxious to test their power of germination, watched his pots every day with great concern. His children, who were clever enough to notice their father's anxiety, sowed some fresh wheat in the pots, which of course did germinate. The professor, thus deceived, wrote that he had been able to germinate the mummy wheat. Some years later, when the children grew and told him the truth, he published a contradiction, which has not been noticed so widely as the original report. Recently some samples of wheat found in the excavations at Mohenjodaro and believed to be 4,000 years old, were put to a test by Prof. J. C. Luthra of Lyallpur (see *Curr. Sci.* 1936/37. p. 489), and, as expected, they were found to be completely carbonized and incapable of ge[illegible]tion.

Psychological Approach to Criminology

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Psychology has exerted its influence on Criminology to a great extent. It has profoundly modified the old ideas about criminality, and by putting forward new theories of crime it has drawn attention to the needs of reforming the existing methods of punishment. Our purpose in this article is to consider whether and how far the Indian Law of Crime has been affected by the psychological theories.

'Crime' means an act or omission made punishable by the sovereign political authority, while 'criminal' means an individual who commits a crime. So crime is the creation of law and can therefore be committed only in an organized society. The essential conditions of crime are—*(i)* it must be done by a person of competent age and of sound mind, *(ii)* it must be done voluntarily and with criminal intention, and *(iii)* it must be punishable by the authority.

Psychologists approach the problem of crime from a new angle of vision. They hold that there is no fundamental difference between crime and neurosis. According to them crimes and mental diseases are both anti-social and abnormal traits, because in both of them " we are concerned with a secret, with something hidden." Therefore to understand the problem of crime we should clearly understand the criminal mind and this can be done by following more or less the same methods and technique that are used in detecting the causes of mental diseases.

Under the Indian Law a child under seven years of age[1] is free from criminal liability. A child between seven and twelve years of age[2] or a person of unsound mind[3] or a person under involuntary intoxication[4] is exempted from criminal responsibility only when he is incapable of knowing the nature and criminality of the act. A person of competent age and of sound mind is liable for his act, because the presumption of law is that every person is of sound mind and possesses sufficient reasoning capacity as to be responsible for his act. The law, however, exempts him from criminal liability if he can prove that he acted in *good faith* or he did it only " to avoid consequences which could not otherwise be avoided, and which, if they had followed, would have inflicted upon him or upon whom he was bound to protect inevitable and irreparable evil, that no more was done than was reasonably necessary for that purpose, and that the evil inflicted by it was not disproportionate to the evil avoided."

The crimes may be classified under the following heads: -

1. Political
2. Non-political--*(a)* Economic, *(b)* Sexual, *(c)* Revengeful
3. Pathological

Political crimes--Severe penalties are on criminals who in any way try to jeopardise the interest of the State. *(cf.* Bengal Regulation III of 1818, Madras Regulation II of 1819, Bombay Regulation XXV of 1827, the State Prisoners Acts

1. "Nothing is an offence which is done by a child under seven years of age." (Sec. 82, I. P. C.)

2. Nothing is an offence which is done by a child above seven and under twelve years, who has not attained sufficient maturity of understanding to judge of the nature and consequence of his conduct." (Sec. 83, I. P. C.)

3. "Nothing is an offence which is done by a person who, at the time of doing it, by reason of unsoundness of mind, is incapable of knowing the nature of the act or that he is doing what is either wrong or contrary to law." (Sec. 84, I. P. C.)

4. "Nothing is an offence which is done by a person who at the time of doing it, is, by reason of intoxication incapable of knowing the nature of the act, or that he is doing what is either wrong or contrary to law; provided that the thing which intoxicated him was administered to him without his knowledge or against his will" (Sec. 85, I. P. C.)

of 1850 and 1858, Bengal Criminal Law Amendment Act of 1930, Bengal Suppression of Terrorist Outrages Act XII of 1932). As a matter of fact the political criminals hazard their interest, their freedom, their home and affection, and even their life for what they conceive to be the well being of the society and the nation. They stand against the powerful with the idea of redressing the grievances of the weak. They aim at the deliverance of the oppressed or the subjugated people from the oppressors. They are not actuated by the same sort of motive as incites the ordinary criminals.

Non-political crimes Non-political criminals on the contrary are actuated by the motive of self-interest, e.g., desire to gain or to dominate, cupidity, etc.

Pathological crimes There is always an apparent motive in the commission of ordinary crime, but there is no apparent motive in the pathological crime. Here an individual commits theft of objects that are of no consequence or are of small value (kleptomania), or assaults another person or persons without being excited (sadism). It is only in the case of the rich and generous persons, that this tendency is considered as a disease.

Now the question is what are the causes that make an individual a criminal. Various theories have been formulated. It is sometimes said that criminals are born as such. The origin of this notion is probably due to the teaching of Lombroso who advocated that the criminal mind is a special type of mind that is inherited and transmittted as such. Psychology has however brought to light that this 'special type of mind' described as criminal is found not only among the criminals detected and punished, but is also to be noticed among the honoured and respected groups of the society who can in no way be considered as belonging to the hereditary criminal class. The criminal tendency, therefore, is not always inherited but may be an acquired trait as well.

Another theory maintains that the criminals are not of the normal calibre their mentality being below par. If we consider the mental capacity of the criminals we often find that the criminals are not always abnormal persons or persons of low intelligence. Among the criminals there are persons who are as intelligent as geniuses and there are also persons who are no better than idiots. Probably the theory has its origin in the fact that the intelligent criminal usually evades the law to gain his own object, whereas the criminal of low or defective intelligence falls an easy victim to the law of the courts.

A man's behaviour is largely determined by environmental conditions. So it is natural to ask whether environment is a factor of crime. There is no doubt that the favourable or unfavourable environment produces a good or a bad man. In poverty people often commit crimes to keep body and soul together. But it can be said that environment, e.g., poverty, destitution, etc., is not so powerful a factor as the mental state because there are thousands of persons in India who wake up in the morning without knowing what they will eat or where they will sleep at night, still they are as honest as possible, and direst poverty and destitution cannot tempt them in any way to commit any crime. Therefore although poverty is one of the causes of crime, it can be said that it is not the determining cause of it.

Ignorance of law is sometimes held to be a cause of crime. This theory can be easily set aside on the ground that on account of complexities of the system of law even the courts sometimes find it difficult to decide what the law is on a particular point. Moreover the knowledge of punishment cannot prevent some persons from ; crimes as the knowledge of the disastrous consequence of venereal diseases cannot prevent some persons from indulging in profligacies.

A view is prevalent that the religion prevents people from committing crimes. It is true that religion, in the usual sense of the term, moulds not only the spiritual but also the social and political life of an individual, but when we consider the effect of religion on the mind of the criminals we frequently find that it has no deterrent effect on them. In the name of religion people often commit unthinkable offences. Instances of this can be found by scores in any religion.

As to the cause of crime the fundamental assumptions of psychology and law are different.

From the psychological point of view, motive is the most important constitution in the commission of crime, but from the legal point of view, intention is the most important factor. When we consider the meanings of the words 'motive' and 'intention' we find that they are not so different as they seem to be. Only difference between them is that one is the part of the other. "The word 'intent' by its etymology, seems to have metaphorical allusion to archery, and implies 'aim' and thus connotes not a casual or merely possible result—foreseen perhaps as a not improbable incident, but not desired but rather connotes the one object for which the effort is made—and thus has reference to what has been called the dominant motive, without which the action would not have been taken." Therefore intention shows only the nature of the act which the man believes he is doing. Motive on the contrary, "is the reason which induces him to do the fact which the intends to do or does." The law ignores the motive and recognizes the intention of the act, but psychology which looks at the root, is concerned more with the motive than with the intention. In dealing with crimes, modern psychology, therefore, insists that the motives of the criminals should be adequately considered.

In order to bring the trial to a speedy close, the court takes into account the confessions of the accused and the evidence of the accomplice. The law on the relevancy of the confession is—"A confession made by an accused person is irrelevant in a criminal proceeding, if the making of the confession appears to the Court to have been caused by any inducement, threat or promise having reference to the charge against the accused person, proceeding from a person in authority and sufficient in the opinion of the Court, to give the accused person grounds which would appear to him reasonable for supposing that by making it he would gain any advantage or avoid any evil of a temporal nature in reference to the proceedings against him." (Sec. 24, I. E. A.) The court, therefore, takes special care in considering the confession of the accused in a criminal trial. "A magistrate shall, before recording any such confession explain to the person making it that he is not bound to make a confession and that if he does so it may be used as evidence against him and no magistrate shall record any such confession unless upon questioning the person making it, he has reason to believe that it was made voluntarily." (Sec. 164(3), Cr. P. C.)

Inspite of all the precautions taken for admitting the confession of the accused, the law makes an error, because it presumes that "no man will voluntarily make a statement which is against his interest," but it is not infrequently found that a person may voluntarily make false statements under certain conditions, *e.g.*, self-delusion, despair, guilty conscience, prison-life, etc.

As regards the evidence of an accomplice the law is "An accomplice shall be a competent witness against an accused person; and a conviction is not illegal merely because it proceeds upon the uncorroborated testimony of an accomplice." (Sec. 133, I. E. A.)

In the case of evidence of an accomplice, the law acknowledges the sound principles of psychology. The testimony of an accomplice, who is a *particeps criminis* and who is usually interested in the result, is looked upon with suspicion. Such evidence is admitted only when it becomes impossible to bring the offender to justice. The Evidence Act therefore lays down a rule of guidance for the court. The court may presume that an accomplice is unworthy of credit, unless he is corroborated in material particulars." (Sec. 114, III. (b), I. E. A.)

We shall now consider the effect of punishment, but before doing that let us first see what the object of punishment is. Regarding the origin of punishment it can be said that it was primarily meant for taking revenge on the wrong-doer or to be more psychological it was the libidinal element trying to "gratify the sadism of the punitive bodies," but with the progress of time, the original idea of punishment has undergone many changes. Punishment is now regarded as a necessary measure for *(a)* the reformation of the criminal, *(b)* the protection and defence of the society and *(c)* the prevention of future crime and warning to others. The original idea of revenge seems to be still predominant in the present system as is evident from the kind and degree of punishment. The desire to punish an offender for

committing an offence is to satisfy the feeling of revenge excited by the crime. Mayne in his *Criminal Law of India* says "that in the case of crimes, it is the duty of the State to undertake the prosecution of the offender and to sentence him on conviction in a way that may operate as a punishment to him and as a warning to others."

Under the criminal law of India the following classes of punishment are inflicted for committing different offences.

1. Death,
2. Transportation,
3. Penal servitude,
4. Imprisonment—Rigorous and Simple with or without solitary confinement,
5. Forfeiture of property,
6. Fine,
7. Whipping, and
8. Detention in Reformatories.

Penal servitude is inflicted on Europeans and Americans as an alternative to transportation. Solitary confinement is awarded in addition to imprisonment, but not as a substantive sentence. Juvenile offenders* are sentenced to or detained in a Reformatory School for a certain period.

Does the modern system of punishment achieve the objects enunciated by Mayne? We give in the next page some tables of the various crimes committed in the Town of Calcutta and its Suburbs during the last few years.

An examination of these tables reveals the following broad facts.

1. The average number of cases between 1928 and 1935 of coining was 35·50; murder, 23·25; robbery 19·63; burglary, 554·25; and thefts, 3732·25.

2. The number of juvenile offenders was the largest in 1929, being 5657. Then there was a well-marked decrease in number till 1933 followed by a rapid increase. The number of offenders sent to reformatories varied between 2 to 6%, *i.e.*, on the average 4%.

The incidence of reconviction of old offenders has increased. Though the number of reconviction varied between 1508 to 3901, yet it can be said that there were on the average 2416·6 convictions a year.

We can thus see that the present method of punishment is not suitable for the prevention of crime or for the improvement of the criminals.

It would not be out of place to consider the effect of punishment on the criminals. It is a common belief that punishment prevents crime. It is true that punishment restrains crime to a certain extent, but it does not prevent the development of criminal urge in the individual; that is to say, punishment does nothing more than suppress to a certain degree the criminal acts. The most striking fact about punishment is that it produces different effects on different individuals. What is punishment to an individual may not be so to another. Imprisonment to a poor, destitute individual is not a severe punishment, because for him prison is nothing but a home and he is sometimes better off in prison, but it is a severe punishment to an individual who leads an outdoor life. A fine of hundred rupees is a terrible punishment to a poor man, but it is practically no punishment to a rich man. Imprisonment instead of preventing crimes often becomes one of the causes of the increase of crime. It is no wonder therefore that the prison is looked upon as the Institute of Crime. Here all kinds of criminals mix freely and thus some of them get an opportunity to learn what they could never know otherwise. Imprisonment sometimes affects an individual in such a way that he finds himself in a helpless condition outside the prison and thus fails to adjust himself in the midst of the society. Moreover the society often does not forgive him for treading a wrong path, and thus makes his life hard for him. Therefore when all his attempts to remain in the right path fail, he commits crime with the sole object of going back to his old habitat or turns into a professional criminal. So imprisonment far from stopping crimes often gives rise to additional crimes.

* "Juvenile offender means an offender whom the court, after making such enquiry (if any) as may be deemed necessary, shall find to be under sixteen years of age, the finding of the court in all cases being final and conclusive." (Sec. 5, Act. IV. of 1909)

PSYCHOLOGICAL APPROACH TO CRIMINOLOGY

As regards the effect of solitary confinement, the law says that loneliness would reform the criminal. But psychologists say that the man is a social being and unless he is allowed to live among his fellows he is like a fish out of water. So from the psychological point of view, solitary confinement, instead of doing any good, tends to affect the mental health of the criminal.

With regard to punishment on pathological criminals, it is to be noted that punishment fails to produce any effect unless and until the obscure and concealed psychic causes are explored.

TABLE I.

	1928	1929	1930	1931	1932	1933	1934	1935	Average
Coining :									
No. of cases	23	29	27	40	36	56	40	33	35·50
Cases sent up	20	29	27	40	36	55	40	32	34·88
Cases convicted	17[1]	14[2]	20	25	27	41	34	19	24·63
Persons convicted	22	18	23	34	33	52	45	19	30·75
Murder :—									
No. of cases	23	16	20	28	32	28	21	18	23·25
Cases sent up	11	7	20	17	24	20	14	15	16·00
Cases convicted	2[3]	6[4]	4	6	5	11	6	10	6·25
Persons convicted	2	7	7	8	7	17	10	13	8·88
Robbery :—									
No. of cases	15	17	28	22	24	19	16	16	19·63
Cases sent up	12	13	22	22	21	17	14	10	16·38
Cases convicted	6	8[5]	15	14	17	14	13	8	11·88
Persons convicted	8	8	29	29	31	25	27	12	21·13
Burglary :—									
No. of cases	921	645	589	479	438	432	426	504	554·25
Cases sent up	460	349	304	299	266	234	229	234	296·88
Cases convicted	384	305[6]	264	245	222	212	216	217	258·13
Persons convicted	467	356	324	299	270	256	286	260	314·75
Thefts :—									
No. of cases	4672	4516	4247	3390	2937	2908	3084	4104	3732·25
Cases sent up	1757	1824	1[illegible]88	1460	1359	1366	1324	1609	1533·38
Cases convicted	1478	1532	1253	1205	1151	1098	1176	1348	1280·13
Persons convicted	1625	1671	1496	1307	1306	1240	1306	1460	1426·38

1. 4 pending. 2. 7 pending, 3. 5 pending, 4. 1 pending, 5. 3 pending 6. 8 pending.

To understand crime we should look into the unconscious roots of social desires and motives. If we can understand the mind of the criminal clearly then possibly we can take such measures as will tend to prevent the development of criminal urge. Punishment is effective only when it aims at the removal of the mental attitude which prompts the criminal to anti-social acts. Unless it does so it will fail not only to effect a decrease but will rather bring in an increase in the number of crimes. (*cf.* Table III.). In that case punishment becomes really more injurious than the evil sought to be prevented.

As it has been said before, the same sort of punishment can never be effective in the case of all persons. The machinery of punishment should therefore be so adjusted as to reform and restrain the offender and to prevent the crime in the society. It should be enhanced to such an extent that it does not produce a demoralizing and degenerating effect on the criminal or retard the growth of the higher and nobler qualities of of the criminal.

G. P. Hogg, Chief Secretary to the Government of Bengal, rightly observed in the case of beggars. that, " the procedure under the present law for dealing with this problem is far from satisfactory. Action absorbing much time and public money not infrequently results in the discharge of the accused after a warning or a sentence of detention

TABLE II

Juvenile Crime

	1928	1929	1930	1931	1932	1933	1934	1935	Result of the cases sent up in %
Sent up	3563	5657	2987	1572	1020	1061	1570	2485	
Warned and discharged	1949	2560	751	831	324	581	1014	1863	49·57
Bound down as first offenders	30	41	120	46	76	112	146	96	3·37
Whipped	183	689	242	43	26	21	46	18	6 37
Fined	934	1802	1394	386	296	170	156	239	26·99
Sent to reformatories, etc.	102	109	145	71	67	66	99	99	3·80
Acquitted	229	219	165	160	22	58	48	51	4·78
Detained till rising of the court	115	214	153		162	53	38	69	4 04

TABLE III.

	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	Average
Old offenders reconvicted	1598	1779	1848	2043	1777	2548	2750	2923	3901	2979	2416·6

till the rising of the court."[1] What Hogg said in the case of the beggars may also be said in the case of juvenile offenders, (*cf.* Table II), and to a modified extent in the case of other offenders. Every effort should therefore be made to bring out what is human in the criminal, *i.e.*, every facility should be given to develop his nobler qualities so that in course of time he may be a useful member of the society. It is in this task that modern psychology can help us a good deal.

Prevention of crime is really the most difficult problem a society has to face. On the whole it can be effected by *(i)* change of environment, *(ii)* control over the environmental factor, *(iii)* change in the mental constitution of the criminals and *(iv)* by introducing changes in the present system of trial.

It would be a definite improvement, I venture to think, if in the trial the court be helped by a separate department manned chiefly by psychologists and physicians. The function of the department should be *(a)* to make proper enquiries into *(i)* the environmental factor, *(ii)* the past life, character and mental constitution of the criminal, and *(iii)* the psychological motive for the present crime; and *(b)* to determine what should be done for the reformation of the criminal. The court should stop after making preliminary enquiry as to the guilt or innocence of the accused. Then on the basis of the enquiry by the separate department, it should pass such orders as would be required for the reformation of the criminal and for the defence of the society.

Psychology has not as yet exercised much influence on the Indian Law of Crime. It is certainly regrettable that the method of trial and punishment of criminals in India should still remain unaffected by the valuable researches in criminal psychology that are going on all around us. Let the lawyers realize their heavy responsibilities in the matter and the sooner they do so the better would it be for the society.

1. Annual Report on the Police Administration of the Town of Calcutta and its Suburbs (1934).

Forecasting Mountain Water Supply by photographing Snowfall

It has long been recognized by users of water from streams along the eastern slope of the Rocky Mountains that a bountiful supply of snow along the Continental Divide in April means a bountiful supply of water and *vice versa.* Demands for accurate information for predictions have resulted in various methods of determination. During the past few years H. L. Potts, water rights engineer for the Denver Board of Water Commissioners, has been developing an original method of forecasting runoff from the accumulated snowfall. At regular times during the year, but most frequently during the past winter and early spring, Mr. Potts has been taking pictures at the same spot on the Continental Divide, located near Hoosier Pass. Each of these pictures is identical as to location and takes in a panorama of many miles, including rugged mountain peaks. After each picture is taken the percentage of the snow area is determined for comparison with other pictures. During the runoff season gaging stations are maintained as a means of checking the amount of water actually produced. Curves are plotted from this information, to which is added a graph to show the amount of precipitation from rain during the late spring and summer. This information is being accumulated with the anticipation that in the future it will be possible whenever a picture is taken and the percentage of snow area determined, to predict the amount of runoff from snow that can be safely counted upon. Although the photographic investigations have extended over a comparatively short period of time, the results have thus far been gratifying.

Jour. Frank. Inst., Sept. 1937.

Notes and News

Agricultural Research in India

We give below in short the recommendations and suggestions made by Sir John Russell, director of the Rothamsted Experimental Station, who came to India last cold weather to report on the working of the Imperial Council of Agricultural Research. His report has just been published, and in it Sir John has sought to find an answer to the question, what can and must be done to make India's soil produce more? He recommends an extension of the activities of the Council and a widening of its powers.

"Agricultural and scientific services should be set up with the double purpose of educating the cultivator so that he may better understand the natural forces with which he is dealing, and of increasing his means of tackling the serious problems with which he is confronted."

His first and second recommendations read: "The success of the Council's efforts shows that its general organization and research programme are both sound and that it is a very effective agent for the improvement of Indian agriculture.

"My proposals are for an extension of its activities, but always with the same purpose—increased production from the soil of India.

"An organized research scheme implies a definite plan for agricultural improvement and means of ensuring that the results of research work are put into practice. I recommend, therefore, that the powers of the Council be widened to comprise development activities as well as research activities."

Throughout the report Sir John emphasizes that the most important and most difficult task before agricultural officers in India is to bridge the gulf separating agricultural experimental stations from the peasants. A fuller use of the existing scientific knowledge is needed and it is recommended that the Council should immediately inquire how this can best be done.

He suggests that workers in experimental stations should repeat in simplified form their experiments on the cultivators' fields in their neighbourhood. He mentions in more than one place that there is a desirability for taking a complete holding, not merely a plot, when trying out a new method.

On the subject of the study of insect pests, Sir John considers that the really important thing is not so much the working out of the life histories of insect pests but a survey in the field of how these pests increase and decrease, and, particularly, of the conditions which are favourable and unfavourable to them. It may then be possible to work out changes in methods of cultivation that will enable a crop to escape the pest or will reduce the pest to such proportions that it will be really negligible.

Another point which he mentions repeatedly is the necessity for a really scientific system of sampling for all types of research. In this matter, the help of expert statisticians is required.

Sir John being himself essentially a soil scientist, his remarks concerning a group of dry farming research schemes are peculiarly helpful. So also are his comments and criticisms on manurial experiments for all crops.

He insists on the need for re-planning many of these on more uniform lines with clearer aims.

Emphasis is laid on the need for work on "cash" crops to be done in association with expert buyers or users of these crops.

The fourth recommendation deals with the work on crops mainly retained for food in the country. Sir John emphasizes the need for this work being done in association with nutrition experts. In the case of both types of crops the need for higher yield is stated thus: "This increased productiveness is the main problem to which all other should be subordinated."

He envisages, as a result of such increased productiveness, the liberation of land for supplementary crops and for fodder. This result is again intimately connected with nutrition, since among these supplementary crops he hopes to see a great increase in fruit and vegetables, particularly green leaf vegetables, while the putting of more land under fodder means a bigger and better milk supply.

Sir John Russell recommends the subsidizing of university workers but says that such grants should be essentially personal. This is a safeguard so that the subsidizing of university work shall not simply mean increasing the funds of the institutions.

He also recommends (in recommendation 7) the setting up of a soil conservation committee to collect the results of manurial trials, to watch regions liable to erosion and to work out schemes in connexion with them and for various other purposes.

In recommendation 9 he suggests the establishment of a crop production committee with very extensive terms of reference to deal with the consideration of cropping schemes, much on the lines adopted by the crop planning conference; general oversight of programmes of research work on crops; organization of watching services to report on the incidence of insects and fungus pest and noxious weeds or other enemies of crop production and to arrange for the working out of control measures.

In his eleventh recommendation he remarks: " None of these proposals can attain much success unless the standard of country life is raised, and this necessitates the settlement of more educated men and women on the land."

He recommends that the machinery at the disposal of the Council for carrying out its work should consist of --

(a) The Imperial Agricultural Research Institute at New Delhi, which should work in close co-operation with the Council and whose programme would be largely dependent upon the problems confronting the Council; *(b)* a marketing branch, *(c)* a cadre of approved investigators and *(d)* a staff of temporary investigators.

His last recommendation deals with funds and runs as follows: " These recommendations, if carried into effect, will necessitate an increased grant to the Council. I, however, see no other alternative to an acceptance of this suggestion.

" The Council is a co-ordinating agency which provides invaluable assistance to provincial agricultural departments and will afford still greater help if it is given wider development powers that will enable it to bring to fruition investigations which at present stop at the experimental stage."

Medical Profession in India

An important report on the organization of the medical profession in India is published in a recent issue of the British Medical Journal. It embodies the opinions expressed to Dr G. C. Anderson, the Secretary of the British Medical Association during his visit to India in 1936 37 and these views are not necessarily shared either by Dr Anderson or the Council of the British Medical Association at the direction of which he undertook his visit to India. He travelled more than 10,000 miles during his investigation. He visited some 20 centres of medical works, inspected institutions of all types from the largest hospital to the smallest country dispensary; and discussed the problems of medical service with all grades of practitioners and administrative officers. At the same time, he points out that " a much longer and wider inquiry would be necessary for the presentation of an exhaustive review of the opinions of all sections of the profession in all parts of the country There may be, and probably are, other views which were not expressed to me."

There are references in the report chiefly to the paradox that while, in the towns, qualified native practitioners may be crowded together to " the verge of starvation," there are also " large tracts of country where no medical pratitioner is within reach of the populace."

Discontent at the superior conditions and opportunities is said to be enjoyed by English doctors both in the Indian Medical Service, and in regard to hospital appointments.

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The existence of medical schools, run by private enterprise, where the student receives no training in biology whatsoever, "political or religious pressure being brought to bear in order to permit recognition as a training school."

The market is flooded with drugs and preparations of impure quality and defective strength. "It is a well known fact," the report states, "that firms in other countries manufacture cheap and inferior quality drugs especially for the Indian market with the result that local producers follow suit."

We should particularly like to draw the attention of the reader to what the report says with regard to the conditions of the medical profession as it exists in the country.

With regard to country districts, the report states: -

"These areas, which constitute the real India, are particularly without any suitable or adequate medical attention, whilst the profession is markedly over-crowded in the cities, in some instances to the point of starvation.

"Provincial Governments, municipalities and district boards provide rural hospitals and dispensaries so far as their finances will permit, but the greatest difficulty is to get any grade of qualified practitioner to live in the rural areas. The pay offered is of course very small indeed, about Rs 70-100 per month while in some areas it is even lower. There are no social amenities in the rural areas, sanitation is a thing unknown, and adequate housing accommodation is not available."

And with regard to conditions in town and cities, it goes on to say.-

"Licentiates, who formerly took posts as sub assistant surgeons, now practise in increasing numbers in the larger towns and, notwithstanding their inferior training, complete freely with graduates. Thus the licentiate who was originally trained to act under the authority of a medical officer in one of the superior medical services is now practising medicine on his own, flooding the market to such an extent that in the larger, and indeed in some the smaller towns there is decided overcrowding in the medical profession.

"This congestion becomes most acute in large cities, in the majority of which a considerable number of medical men are finding it almost impossible to make a living, indeed many are on the verge of starvation."

The main reasons for this are the economic condition of the people and the lack of facilities for employment in public health services. Public health activities in India are unfortunately negligible. There is as yet no compulsory medical inspection of school children; the municipalities and other local bodies are not compelled to engage health officers and there is no provision for food inspection. If these were provided for by the State, they would not only open up employment for a large number of qualified medical men, but would also add to the forces for fighting the spread of epidemics and preventible diseases. There is a growing tendency among the public to obtain the services of medical men and hospital facilities free of charge. Unless this is checked in time and the abuse of free treatment in hospitals by people who can afford to pay is stopped, it will add to the difficulties of the situation.

We are glad that Dr Anderson has also raised his voice of protest against the importation into India of drugs of impure quality and defective strength. It is high time that the Government should give effect to the well-considered recommendations of the Chopra Committee regarding the establishment of Government laboratories to test drugs imported into India or manufactured locally.

We find it, however, difficult to agree with Dr Anderson that medical ethics in this country is very low. We can do no better than quote what Dr B. C. Roy says on the point, "I must emphatically deny Dr Anderson's statement that the standard of medical ethics in this country is very low. We, in this country, had for centuries a high standard of medical ethics and rules, which have been elaborately laid down in the Ayurveda, and believe that the medical men in India who practise allopathy observe these rules and traditions either consciously or unconsciously."

Nutrition Defects In India

The importance of the question of nutrition in relation to public health is stressed by the Public

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Health Commissioner with the Government of India in his annual report for 1935.

The report points out that regrettable though the extent of the major epidemics such as cholera, plague, and smallpox may be, there are still other diseases which cause much greater havoc although perhaps in a less dramatic way. Malaria, tuberculosis, leprosy, infant mortality and maternal mortality constitute grave dangers to the public health. In all these five groups there exists a common predisposing aetiological factor which is of vital importance. This predisposing factor is nutrition.

The report says: "No preventive campaign against malaria, against tuberculosis or against leprosy, no maternity relief or child welfare activities are likely to achieve any great success unless those responsible recognize the vital importance of this factor of defective nutrition and from the very start give it their most serious attention. Abundant supplies of quinine and the multiplication of tuberculosis hospitals, sanatoria, leprosy colonies and maternity and child welfare centres are no doubt desirable, if not essential, but none of these goes to the root of the matter. The first essentials for the prevention of disease are a higher standard of health, a better physique and a greater power of resistance to infection. These can only be attained if the food of the people is such as will give all the physiological and nutritional requirements of the human frame.

"This question is obviously closely correlated with that of population and with the planning of sufficient and suitable food supplies. To obtain the best results, a close liaison must be maintained between the human nutrition research workers and those who can bring influence to bear on the food producer. Only when that liaison has been able to effect quantitative and qualitative improvements in food supplies which research has shown to be so urgently necessary, will it be possible to anticipate any great or permanent reduction in the incidence of those diseases which at present take such a pitiful toll of human life in this country."

The report refers to the rapid growth of interest on the question of nutrition in this country, especially since the assumption of the Viceroyalty by Lord Linlithgow, and the research work done in this direction in the laboratories at Coonoor and Calcutta. The need for practical application in the homes of the people of the fruits of research, is also being energetically pursued.

Some of the most interesting pages of the report are devoted to the subject of tuberculosis. The disease, particularly in its pulmonary form has markedly increased during the last three decades, especially in the large urban and industrial areas. Only within recent years, however, has the infection begun to spread to villages, this extension of infection being partly due to the return of infected industrial workers to their homes and partly to the great development of road transport. The report urges the need for at least one clinic in every municipality and rural town. The report while not denying that additional hospitals and other beds are necessary, points out that these are by no means the first requirements of an anti tuberculosis campaign.

The report after referring to the problems facing the maternity and child welfare movement in India says: "An important factor in an efficient maternity service is ante-natal care of the mother. Much requires to be done in India in this connexion. It is stated that many of the hospitals attached to medical colleges and medical schools and training institutions for midwives have inadequate arrangements, and the students leave college with a minimum knowledge of the scope and value of ante-natal work. This work should, of course, be an activity in every infant welfare centre, but progress is made difficult because few realize the importance of preventive work in this field.

Apart from the scarcity of training schools and of trained midwives, a serious handicap exists in the lack of supervision of the midwives and their practice. No full time inspectress of midwives has yet been appointed in any province, and supervision of the midwives in private practice does not exist.

The account given of child welfare work is not encouraging. Approximately 800 infant welfare centres have been established, while some 60 medical women and 250 trained health visitors are employed in maternity and child welfare services now in existence in the country. Unfortunately, a considerable number of the centres are said to be badly organized, their work is not co-ordinated, their records are not

properly kept, and the information which is collected is not made available for future planning.

The following extract from the report gives a vivid idea of the magnitude of the problem: "A total of 2,848,099 or 43% of the deaths registered during 1935 occurred among children under the age of five years. Maternal deaths from child-birth are estimated to account further 150,000 to 180,000 deaths annually.

"Fire-Swallowing"

Khuda Bux, the Indian magician, created sensation in scientific circles by his fire-walking feats and appeared difficult to the scientist for some time to find out an explanation of this seemingly unbelievable power to stand red-hot embers under his feet. However, that has now been explained, and the explanation has satisfied the scientist. Now comes a report from Ferozepore that one Pandit Hargopal of Sohal, Amritsar District, would easily swallow live coals -he loves to do it. Hargopal does not claim to be a magician, but if the report is to be believed he feels an irresistible urge within himself to gulp down burning embers, and he does so, we are told, without any harm to his tongue or mouth or throat.

Here is another problem, which, if the report be true, will engage the serious attention of the scientist. We have, however, little doubt that a rational explanation will soon be forthcoming, but the veracity of the report ought to be checked first of all.

High Commissioner's Report on Indian Students

The report on the work of the Education Department of the Office of the High Commissioner for India in London for the year 1935-36, which has recently been published, states that "there has actually been increase to about 1,350, as compared with the corresponding figure 1,316 during 1934-35. The number of new applications for admission indeed shows an even more marked increase from 617 in the previous year to 760 for 1936-37, whilst the number of offers of admission received on behalf of Indian applicants has risen from 465 to 561."

The report continues that two hundred and six students were formally under the supervision of the Department during 1935-38, including 116 State and Special scholars, 27 students in receipt of grants or allowances from Private Memorial or Trust Funds, 40 Indian Civil Service and Forestry Service Probationers, eight students awarded grants-in-aid, and fifteen private students entrusted to the care of the High Commissioner for the purpose of their education in this country.

Seven hundred and sixty applications for the session beginning October 1935 were received and the total number of offers of admission received was 581. The remaining candidates either withdrew their applications or were not qualified to enter upon the proposed course or applied at a late date after all the vacancies at the desired institution had already been allotted.

The largest number of full-time students was in the Faculty of Medicine, in which 464 students were registered, while Arts (including Education and Law) comes second with 312 students. Engineering and Technology come next, with 201 students, and Pure Science and Economics follow with 142 students and 104 students respectively. Agriculture had 52 students, and 75 were studying various unclassified subjects. In addition, there were about 208 students (including 4 women) pursuing part-time occasional courses in the various Faculties, while there were 177 students (including 38 women) in attendance at the educational institutions like the Architectural Association, Faraday House, Electrical Engineering College, London School of Printing etc. Indian members of educational institutions in this country have again achieved noteworthy academic, athletic and other successes.

Whilst the number of students to be found at most of the Universities and Colleges throughout the United Kingdom has increased, the improvement in their general standard of ability and attainment has undoubtedly been maintained. It is gratifying to note during the period under review the successes and distinctions again won, especially at the post-graduate stage in the various Faculties. In medicine and surgery the following high professional qualifications were obtained. Eight students were awarded the Fellowship of the Royal College of Surgeons, England, and seven the membership of the Royal College of Physicians, London; two Indian doctors gained

the high distinction of the Fellowship of the Royal College of Physicians, Edinburgh, nine the Membership of the same institution, and six the Fellowship of the Royal College of Surgeons, Edinburgh. In science four students were awarded the important degree of D. Sc.; twentyfour obtained the Ph. D.; and twelve the degree of M. Sc. In the Faculties of Arts and Economics, etc., no less than fourteen students were awarded the degree of Ph. D. This noteworthy record of post graduate distinctions not only reflects great credit on the students concerned, but may be regarded as a tribute to the excellence of the training which they obtained at their Indian Universities before proceeding abroad. The number of women students remains fairly constant, the majority being engaged in medical studies and courses leading to the Teachers' Diploma.

Lord Nuffield's Latest Gift to Oxford

Lord Nuffield, who has become famous for his munificent grants for educational purposes, has again offered £1,000,000 recently to the Oxford University for the building of a new college to be devoted to collaboration, particularly in social studies, of theoretical students with practical men of affairs. With it he has offered a site, on which the new college is to be built. Lord Nuffield hopes that the college will produce a flow of recruits to industry. One of the conditions for the acceptance of the offer is that part of the endowment shall be devoted to the establishment of the Fellowships of three classes—full-time Fellows, to conduct research and assist teaching; unofficial Fellows already holding office in the university or its colleges; and part-time Fellows, with practical experience in the professions, industry or commerce.

It is proposed that the new college will be named after Lord Nuffield. Referring to the gift, Mr. A. D. Lindsay, Vice-chancellor of the Oxford University, said that it would be unique. It would not be in any sense a rival to existing historic foundations. It would be entirely a post-graduate college and the people who went there would have already been members of the other colleges. It was really going to be a university instrument of research and it would have to be more under the control of the university than an ordinary college.

Exploration on Shiva's Temple

The romantic mystery which was so long associated with the lost world of Shiva's Temple—the natural stronghold in the Grand Canyon in Arizona - separated by erosion from the walls of the Canyon at least 35,000 years ago has at last been dispelled through the creditable efforts of Dr Harold Anthony, leader of the Patterson-American Museum Expedition, who with his seven colleagues sealed 1200 feet of sheer standstone cliff and explored it. It is probable that no human foot had in historic times ever trod the 275-acre plateau. Dr Anthony, on his return to New York, gave an interesting account of the results of his exploration.

The object of the expedition was to study animal life on the wooded plateau in order to discover whether isolation produced any marked changes in the appearance and habits of creatures and in the hope of gaining useful knowledge of the effects of inbreeding and evolution in general. During his stay on the plateau from September 15 to 26, Dr Anthony shot or trapped some 75 specimens, which have been skinned and will be forwarded to New York for examination. The animals found on the Temple, all of which were extremely wild and nervous of man, were chipmunks, three or four species of mice, which were extremely numerous, cottontail rabbits, rock squirrels, which resemble the common grey squirrel, and pack rats, of which one species may be peculiar to Shiva.

Dr Anthony expressed the belief that the colour of all these animals was lighter than their fellows on the north and south rims of the Canyon, which are respectively one and a half and eight miles in direct line from Shiva, but this remains to be proved visited in winter by deer and by cougar or mountain lion and coyote.
by careful comparison. In addition, the plateau is

The vegetation, consisting of pines, juniper, shrubs, and cactus, is more arid than on the mainland, and the heat on the Temple, which is entirely waterless, is considerably greater than on either side of the Canyon. Many Indian remains were found in the shape of mounds, ovens, and tools, but members of the expedition were the first men to undertake the scientific study of the plateau, of which the area is about 300 acres.

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While no positive results can be yet announced, Dr Anthony believes that it will be possible as the result of the expedition to reach an approximately accurate date for the separation of Shiva from the mainland, and hopes that at least one distinct species of animal may be discovered to exist there.

But on that arid plateau the expedition was chiefly troubled by mosquitoes, and as there is no water on Shiva's Temple, the expedition confessed itself at a loss to discover the breeding ground of the pests.

Facilities for training at the Technological Laboratory, Matunga

As in the past the Technological Laboratory will admit this year two students for training in the elements of spinning and the routine methods of testing cotton fibre and yarn. The selected candidates will be expected to join on the 3rd January 1938 and will conform to the Laboratory regulations regarding hours of work, etc. The course will normally last for a period of six months and a fee of Rs. 50 - only, which is not refundable, will be charged for the full course. Candidates desirous of admission should submit written applications to the Director, Technological Laboratory, Matunga, Bombay, so as to reach him not later than the 10th November 1937.

Sir James Jeans

Due to the sudden death of Lord Rutherford, President-elect of the Silver Jubilee Session of the Indian Science Congress, Sir James Jeans has kindly agreed to preside over it. He is one of the fore-most astrophysicists of today and is a past-president of the British Association for the Advancement of Science (1934).

Silver Jubilee Meeting of the Indian Science Congress.

The arrangements in connection with the visit of the foreign delegation to India, on the occasion of the Jubilee Session of the Indian Science Congress, are now assuming final shape. The tour programme has been divided into two portions, a tour through Central and Northern India before the session and Southern India after the Session. The following are the details of both tours, though it is possible that the visit to Kolar may be omitted and a visit to Mysore substituted.

December 16th	Arrive at Bombay. Received by the University of the Bombay on behalf of the Indian Science Congress Association.
December 17th	Halt at Bombay.
December 18th evening	Leave Bombay in special train.
December 19th morning	Arrive at Hyderabad.
December 20th evening	Leave Hyderabad. During their stay in H. E. H. the Nizam's Dominions the delegates will be the guests of H.E.H. the Nizam's Government.
December 21st morning	Arrive Aurangabad, and visit Ajanta or Ellora by car en route to Jalgaon.
December 21st evening	Leave Jalgaon.
December 22nd afternoon	Halt at Sanchi, and visit the Buddhist stupas.
December 23rd morning	Arrive Agra, and visit the Taj Mahal and the Fort.
December 23rd evening	Leave Agra.
December 24th morning	Arrive Delhi. Visit the Imperial Institute of Agricultural Research Luncheon by the Government of India at the Institute.
December 25th	Visit Old and New Delhi.
December 25th evening	Leave Delhi.
December 26th morning	Arrive Dehra Dun. Visits to the Forest Research Institute and to the Geodetic Branch of the Survey of India, and if time permits to Mussoorie.
December 26th evening	Leave Dehra Dun.
December 27th afternoon	Arrive Benares.
December 28th	Visit the Hindu temples by boat down the Ganges, and the Buddhist remains at Sarnath.
December 28th evening	Leave Benares.
December 29th midday	Arrive Calcutta.
December 29th to January 2nd	Filed excursions to the coal-fields and iron ore area, Tatanagar, Darjeeling, ancient "Gaur," Port Canning, and other places.
January 3rd to 9th	Twenty-fifth Session of the Indian Science Congress at Calcutta.
January 9th evening	Leave Calcutta.

January 11th Morning	Arrive Madras. Reception by the University.
January 11th evening	Leave Madras.
January 12th morning	Arrive Bowringpet for the Kolar Goldfield.
January 12th evening	Leave Bowringpet.
January 13th morning	Arrive Bangalore. Reception by the University and by the Indian Institute of Science.
January 13th evening	Leave Bangalore.
January 15th morning	Arrive Bombay, and leave for Europe.

In addition to the above programme, for which a special train has been engaged, shorter excursions to places of scientific interest in Bengal and Bihar are being arranged for the period December 29th to January 2nd. In these it is hoped that scientists in India will also take part. Details will be announced later.

The Session in Calcutta is likely to be of great interest, for many of the foreign delegates are reading papers and taking part in the discussions, while members of the delegation are also being invited to give the four or five popular evening lectures. Already the following have agreed to give lectures: Sir Arthur Eddington on "The Milky Way and Beyond;" Prof. F. A. E. Crew on "The Biology of Death;" and Prof. H. J. Fleure on "Stages in the growth of Civilization."

Of the papers that are being contributed to the sectional meetings, the following may be mentioned as of special interest. In the ***Mathematics and Physics Sections***, Isotopic weights by the doublet method, by Dr F. W. Aston; Theory of scattering of protons by protons, by Sir Arthur Eddington; Recent eclipse results, and the complex spectra of novae by Prof. F. J. M. Stratton; and the application of electron waves to the study of surfaces, by Prof. G. P. Thomson. In the ***Chemistry Section***, Resonance and molecular structure, by Prof. Lennard-Jones; and Photosynthesis of carbo-hydrates in vitro, by Prof. E. C. C. Baly. In the ***Geography and Geodesy Sections***, Geography and the scientific movement, by Prof. H. J. Fleure; The great divide, by Prof. C. B. Fawcett; and The technique of regional geography, by Prof. A. G. Ogilvie. In the ***Botany Sections***, the nature of the subterranean algal soil flora, by Prof. F. E. Fritsch; The monocotyledonous seedlings of certain dicotyledons, by Sir Arthur Hill; The principles of floral construction by Miss E. R. Saunders; The biology of crossing-over, by Dr C. D. Darlington; and The structure of the chromosome, by Prof. Ruggles Gates. In the ***zoology Section***, The zoogeography of the freshwater fishes of South and East Asia, by Prof. L. F. de Beaufort. In the ***Anthropology Section***, The crisis in modern anthropology, by Baron von Eickstedt; The functions of physical anthropology, by Prof. R. A. Fisher; The anthropology of the Todas, by Prof. L. Cipriani; and Racial analysis by Prof. H. J. Fleure.

It is also expected that the delegates will take a leading part in the discussions and symposia that are being held. Information regarding these will be announced later.

The following is likely to be the final list of delegates, though a few more non-British delegates are expected to come.

LIST OF DELEGATES

Mrs. Ashworth.	Widow of the late Prof. J. H. Ashworth, Professor of Natural History, University of Edinburgh.
Dr. F. W. Aston, F.R.S., Nobel Laureate.	Cavendish Laboratory, University of Cambridge.
Prof. F. G. Baly.	Professor of Electrical Engineering, Heriot-Watt College, Edinburgh.
Harold Baly, Esq.,	74, Lawn Road, London, N.W.3.
Prof. E. C. C. Baily, F.R.S.	Professor of Inorganic Chemistry, University of Liverpool.
Prof. E. Barker.	Professor of Political Science, University of Cambridge.
Mrs. F. Bishop.	1, Summerhill Terrace, Berwick-upon-Tweed, England.
Prof. V. H. Blackman, F.R.S.	Professor of Botany, Imperial College of Science &. Technology, London.
Prof. P. G. H. Boswell, F.R.S	Professor of Geology, Imperial College of Science & Technology, London.
Prof. A. H. R. Buller, F.R.S.	Lately Professor of Botany, University of Manitoba, Winnipeg.
Mr. J. M. Caie.	Assistant Secretary, Department of Agriculture for Scotland,

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Prof. V. Gordon Childe.	Professor of Prehistoric Archaeology, University of of Edinburgh.
Prof. Dr. Lidio Cipriani.	Director of the National Museum of Anthropology and Ethnology of Royal University, Florence, Italy.
Prof. N. M. Comber.	Head of the Department of Agriculture, University of Leeds.
Miss Coxhead.	
Prof. F.A.E. Crew.	Professor of Genetics and Director of the Animal Breeding Research Department, University of Edinburgh.
Dr. E.M. Crowther.	Head of the Chemistry Department, Rothamsted Experimental Station, Harpenden.
Dr. C.D. Darlington.	Lecturer in Cytology, University of London
Prof. C. G. Darwin, F.R.S.	Master of Christ's College, Cambridge.
Prof. L. F. de Beaufort.	Director, Zoological Institute, Amsterdam.
Prof. L. Diels.	Director, Botanical Gardens, Berlin.
Prof. F. G. Donnan, F.R.S.	Professor of Chemistry, University College, London.
Dr. A. L. du Toit.	Geologist, Johannesburg.
T. S. Dymond, Esq.,	14, Albany Road, St. Leonards-on-sea, England.
Sir Arthur Eddington, F.R.S.	Plumian Professor of Astronomy, University of Cambridge.
Prof. E. von Eickstedt.	Director, Anthropological Institute, Breslau.
Prof. C. B. Fawcett.	Professor of Georaphy, University College, London.
Prof. W.G. Fearnsides, F.R.S.	Professor of Geology, University of Sheffield.
Sir Lewis Fermor, F.R.S.	Formerly Director, Geological Survey of India.
Prof. R. A. Fisher, F.R.S.	Galton Professor of Eugenics, University College, London.
Prof. H. J. Fleure, F.R.S.	Professor of Geography, University of Manchester.
Prof. F. E. Fritsch, F.R S.	Professor of Botany, Queen Mary College, London.
Prof. Ruggles Gates, F.R.S.	Professor of Botany, King's College, London.
Prof. W. T. Gordon.	Professor of Geology, King's College, London.
Prof. H. M. Halsworth, C.B.E	Professor of Economics, University of Durham, Newcastle upon-Tyne.
Sir Arthur Harden, F.R S. Nobel Laureate.	Late Head of Biochemical Dept. Lister Institute of Preventive Medicine, London.
Sir James B. Henderson.	Formerly Professor of Applied Mechanics, Royal Naval College, Greenwich.
Prof. J. Hendrick.	Professor of Agriculture, University of Aberdeen.
Prof. J. W. Heslop-Harrison.	Professor of Botany and Genetics, University of Durham, Newcastle-upon-Tyne.
Sir Arthur Hill, F. R. S.	Director, Royal Botanic Gardens, Kew.
Professor Sir Frederick Hobday.	Lately Principal of the Royal Veterinary College, London.
Dr. A. Hopwood.	Consulting Chemist, Eshowe, 43 Hylton Drive, Cheadle Hulme, Cheshire, England.
Dr. O. J. R. Howarth.	Secretary, British Association for the Advancement of Science.
Prof. G. W. O. Howe.	James Watt, Professor of Electrical Engineering, University of Glasgow.
Prof Lennard-Jones, F. R. S.	Professor of Chemistry, University of Cambridge.
Dr. Ll. Wynn Jones.	Lecturer in Psychology, University of Leeds.
Prof. C. G. Jung.	Professor of Psychology, University of Zurich.
James Keith, Esq.,	Pitmedden, Udney, Aberdeen, Scotland.
Miss E. E. Kelly.	541, Old Chester Road, Rock Ferry, Cheshire.
R. H. Kinvig, Esq.	Reader in Geography, University of Birmingham.
Mr. J. Mc Farlane.	Reader in Geography, Universiry of Aberdeen.
Sir Gilbert T. Morgan, F.R S.	Director, Chemical Research Laboratory, Teddington.
Dr C. S. Myers, F. R. S.	Principal, National Institute of Industrial Psychology, London.
Dr. W. G. Ogg.	Director, Macaulay Institute for Soil Research, Aberdeen.
Prof. A. G. Ogilvie.	Professor of Geography, University of Edinburgh.
Mr. H. J. E. Peake.	Vice-President, Royal Anthropological Institute.
Dr. E. P. Poulton.	Physician to Guy's Hospital, London.
J. Ramsbottom, Esq.,	

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Prof. H. H. Read.	Professor of Geology, University of Liverpool.
Dr. A. B. Rendle, F. R. S.	Formerly Keeper of Department of Botany, British Museum, London.
Rt. Hon. Lord Samuel.	President, British Institute of Philosophy, and lately H. M. Secretary of State for Home Affairs.
Miss E. R. Saunders.	Lately Lecturer in Botany, Newnham College, Cambridge.
Lt.-Col. R. B. S. Sewell, F.R.S.	Zoological Laboratory, University of Cambridge.
Prof. J. L. Simonsen, F. R. S.	Professor of Chem'stry, University College of North Wales, Bangor.
Prof. R. V. Southwell, F.R S.	Professor of Engineering Science, University of Oxford.
Prof. C. E. Spearman. F.R.S.	Emeritus Professor of Psychology, University of London.
Dr. L. Dudley Stamp.	Reader in Economic Geography, University of London.
Prof. F. J. M. Stratton.	Professor of Astrophysics, University of Cambridge.
Prof. W. Straub.	Professor of Physiology, University of Munich.
Prof. G. P. Thomson, F.R S.	Profes or of Physics, Imperial College of Science & Technology, London.
Sir Henry T. Tizard, F.R.S.	Rector, Imperial College of Science and Technology, & formerly Secretary, Department of Scientific and Industrial Research.
Dr. A. E. H. Tutton, F.R.S.	Past President, Mineralogical Society of London.
Dr. W. W. Vaughan, M.V.O.	Past President, Education Section, British Association.
Dr. J. A. Venn.	President, Queen College, Cambridge, and Lecturer in History and Economics of Agriculture, University of Cambridge.
Dr. Mary Waller.	Lecturer in Physics, London School of Medicine for Women, University of London.

The membership of the Congress this year is far greater than that of any previous year, and already over 1100 have joined. *It is hoped that all those who intend joining will do so as early as possible,* otherwise they will run the risk of not receiving invitations to the special functions that are being arranged by the Local Reception Committee. Applications for membership should be sent to the Royal Asiatic Society of Bengal, 1, Park Street, Calcutta.

Early in November the Local Secretaries will be issuing a circular letter regarding the local arrangements, and it is hoped that those members who intend to be present at the meeting in Calcutta will give very early intimation to Prof. S. K. Mitra, Local Secretary, University College of Science, 92, Upper Circular Road, Calcutta.

Three special Jubilee publications entitled "The Progress of Science in India during the past Twenty-five years," "As Outline of the Field Sciences of India," and "A History of the Indian Science Congress Association" are being published, and are expected to be ready before the Session. The Executive Committee have decided to issue them free to all Ordinary and Full Session Members, though the cost of publishing them is likely to exceed Rs 7,000/-. The separate chapters of the Outline of the Field Sciences, which are entitled (1) The Weather of India, (2) The Oceans round India, (3) An Outline of the Geological History of India, (4) An Outline of the Vegetation of India, (5) An Outline of the Fauna of India, (6) An Outline of the Racial Ethnology of India, (7) Agriculture and Animal Husbandry, (8) An Outline of Indian Archaeology, are also being published separately, as it is expected that they will be of much value to schools and colleges.

The appeal that was issued nearly a year ago to scientists in India, asking them to contribute donations to the Jubilee fund of the Congress, has up to now met with a rather poor response, only about 53 persons having contributed about Rs 2,800. The sum of Rs 10,000 is being aimed at from this source, and, now that the time of the Session is approaching, it is hoped that members of the Congress will come forward in large numbers and send donations. If the majority of the 1100 members who have already joinedthe Congress were to contribute sum of five andten rupees each, the financial position would be greatly improved. At present it is giving rise to some anxiety. In this connection we would draw the attention of large firms in India to the very generous contribution of the Burma Oil Company, who have given donation of Rs 1500/-

A final appeal is now being issued to members of the Indian Science Congress Association, and we have no doubt that it will meet with a generous response.

Science in Industry

Conservation of Ancient Pieces of Iron

We are very often struck by the fact that pieces of iron and steel several centuries old resist rusting much better than modern samples. All sorts of iron and steel prior to middle of the 19th century, obtained by the Catalonian or pudding furnaces, differ so much by their mode of preparation and composition from the modern fused steels that one attributed to it the real cause of the differences in behaviour of the ancient samples.

As fused iron is distinguished by its purity or from the point of view of its contents in carbon, manganese, silicon, by the presence of layers of slag opposite in oxidation and finally by certain amounts of copper, attempts have been made to imitate these properties by modern processes. But none of the above three factors alone is a sufficient guarantee for the resistivity of iron. However, they impart certain useful properties. Thus on account of the velvety surface of pure iron, the protective layer of enamel or zinc adheres better. It has been equally found that high content of phosporus of the majority of ancient fused iron increased the resistance to oxidation due to copper. This has led to modern (patiné) steels.

In majority of cases like balustrades, flight of stairs, handle or hilt of swords, the conservation of the metal appears to be attributed to the layer of fatty matter deposited by numerous hands which touched the surface.

Finally we must not lose sight of the fact that "industrial atmosphere" charged with gases from the chimney did not exist prior to the 19th century. Various experiments have shown that iron pieces exposed to air in a countryside or in forest are covered with a thin layer of rust which does not increase practically after 10 or 15 years and protects the rest.

Paper Industry in India

According to Mr M. P. Bhargava, officer-in-charge of the paper pulp section of the Forest Research Institute, Dehra Dun, there appears to be good prospects of the manufacture of paper from catta reeds *(Ochlandra Travancoreca)* in Travancore.

He estimated that about 25,000 tons of catta could be obtained from Travancore forests every year, yielding from 8,000 to 10,000 tons of paper pulp, sufficient for the establishment of an economic unit for paper manufacture. Good writing and printing paper could be made from catta, though no scientific experiments in this direction had yet been made at Dehra Dun. Graft paper and packing paper could also be made from catta. The possibility of manufacture of newsprint from catta should, however, be investigated, as newsprint required 70 to 85 per cent. of mechanical pulp.

With regard to the position of the Indian paper industry, Mr Bhargava pointed out that about 45,000 tons of writing and printing paper were now being produced in India, and three or four mills in Bengal were consuming about 50,000 tons of bamboo every year. India had sufficient resources of bamboo to permit of the growth of the industry.

The problem is to find the mechanical pulp necessary for newsprint manufacture. India has vast resources for mechanical pulp in the coniferous forests of the Himalayas but transport difficulties make their utilization economically difficult. The question of obtaining mechanical pulp from other raw materials is now under investigation.

Stores Department and Indian Industries

The annual administration report for 1936-37 of the Indian Stores Department which was released a few days ago publishes the details of the encouragement given to Indian industries. According to it there have been very large increase in purchases of indigenous manufactures.

Purchases on behalf of Railway Administrations amounted to Rs. 3,62,00,000, showing an increase over the previous year of Rs. 71 lakhs. Purchases on behalf of the Army, Royal Air Force and other branches of the Defence Department amounted to

more than Rs. 119 lakhs, an increase of Rs. 16 lakhs over the previous year. Provincial Governments, Indian States, *quasi* public bodies and Colonial Authorities, on whom there is no obligation to utilize the services of the Department, obtained stores of the value of more than one crore of rupees through the Department, against Rs. 84 lakhs during the preceding year. Among the important contracts handled by the Department during the year under review mention is made of broadcasting equipment for All-India Radio (Rs. 10,35,000), an electric passenger locomotive for the Great Indian Peninsular Railway (Rs. 3,15,000.) and a steam raising plant and turbo-alternator set for the New Delhi municipal committee (Rs. 2,92,000).

The Department continued its efforts to substitute, wherever possible, and without sacrifice of efficiency or economy articles of indigenous manufacture for imported products. Details are given in the report of the more important contracts placed during the year for articles which were wholly or partially produced or manufactured in India. These contracts aggregated over Rs. 2 crores, of the total purchases made by the Department during the year. The value of stores inspected in respect of orders placed by the Department amounted to Rs. 4,81,00,000. In addition to these stores the Department arranged for the inspection of wagons, cast iron sleepers and other materials to the value of Rs. 1,17,35,000 and rails, fish plates, structural steel-casting and similar materials, weighing 336,000 tons, on behalf of railways and other authorities, against orders placed by those authorities direct. One of the major orders for which inspection was entrusted to the Department during the year, was for the steel work of the Meghna bridge for the Assam Bengal Railway, which consisted of six deck-spans of 104½ ft. and seven through-spans of 331 ft. of a total value of over Rs. 8½ lakhs. Another interesting example of this branch of the Department's activities was the inspection of the first instalment of material manufactured by Messrs. Tata Iron and Steel Co. for the construction of the new Howrah bridge.

One of the most important activities of the Indian Stores Department is the work connected with the standardization of stores used by various Government departments, and the standardization of numerous articles for use on railways. The latter work is done in consultation with the Central Standards Office of the Railway Board.

Among the articles for which standards were drawn up were abrasive cloth and paper, hurricane lanterns, plate and sheet glass, hoses, bellows, pig iron, bees-wax, electrical cables, rotary convertors water meters, road rollers, drain pipes, handcuffs, platform weighing machines, leather goods, carpets, blanket cloth, linoleum and other goods. Research and testing of samples was carried out by the Government Testing House at Alipore, which is administered by the Indian Stores Department. Investigations, in addition to routine work, covered a wide range and included research on proofed and unproofed jute fabrics, comparative tests to determine the effect of temperature variation on worsted trimmings for use in oil cups in locomotives, tests on clay for building purposes in Quetta, and cement for the new Howrah bridge. The total number of tests and analyses carried out by the laboratories of the Government Test House and by the Metallurgical Inspectorate during the year amounted to 18,228. A collection of articles of indigenous manufacture is on exhibition in the Department in the Imperial Secretariat Buildings, New Delhi.

Sugar Production

The final memorandum on production of sugar, direct from cane, in India for 1936-37, issued by the Director of the Imperial Institute of Sugar Technology, Cawnpore, places actual production at 1,128,900 tons against 912,100 tons during 1935-36. The number of working factories is placed at 140 against 137 during the last season. The total increase in the output of sugar over that of the previous year is considerably higher amounting to 216,000 tons. The total quantity of cane crushed was 11,873,780 tons against 9,801,748 tons last year. This substantial increase in the quantity of cane crushed and the production of sugar is chiefly attributed to the considerably longer duration of the cane-crushing season which was due to the impetus received by factories from the reduction of cane prices in the United Provinces and Bihar in April, 1937. The percentage of recoveries of sugar and molasses was 9·50 and 3·43 compared with 9·29 and 3·43 in the previous year.

A New Durban Company to utilize Bagasse

Bagasse, which consists of the fibre after sugar has been extracted from the cane, is at present used as fuel for the furnace in sugar factories. In all manufacturing business the complete utilization of the waste products is very important. By the Vazacane process, named after Mr E. A. Vazques, who invented and patented it in 1927, it is "possible to join in operation a method for extracting all the juice from the cane and a preparation of the fibres so that they can be directly formed into board, all by a simple mechanical process." News has reached us that following several years of experimental work by the Natal Estates, Ltd., a new Durban Company has been formed to exploit a secret process for the manufacture of paper pulp from cane bagasse. This process has been invented by Mr E. A. Ritter from whom the Durban Company, which has been registered, will purchase the right to use and exploit in all parts of the world other than Africa, south of the Equator, the process for the manufacture of pulp capable of being made into paper, newsprint, card-board, and the like. In India which is the third largest bagasse-producing country in the world the first two being Cuba and Java, steps ought to be taken to utilize it properly. We should draw the attention of our readers in general and the sugar-mill authorities in particular to an important article on "The Utilization of Bagasse" by Dr R. N. Ghosh, published in the July 1937 issue of *Science and Culture*, pp 46-47, where the subject has been fully dealt with, and suggestions made for its proper utilization.

Coal Tar and Coal-Tar Products

We publish the concluding portion of the article in this section titled "Industry of Coal Tar and Coal-Tar Products" by Mr Asoke Bose, the preceding portion having been published in the last issue.

Industry of Coal-tar and Coal-tar Products

(Continued from last issue)

Asoke Bose

The technique of coal-tar distillation has made tremendous progress in Germany, England, France, and in America. It is obviously impossible in an article of this nature to undertake a detailed description of the actual process of distillation as carried out in various works. A few observations of a general nature can, however, be made.

Coal-tar after having been separated from the ammoniacal liquor, which settles out at the top on allowing tar to stand, is distilled in large wrought-iron stills (capacity varying from 5 to 45 tons of tar), set in brick-work and heated by coal or gas-fire with or without the employment of a vacuum. The advantage of distilling tar in vacuum does not merely consist in saving of time and fuel and of reduced wear and tear of the plant, but also owing to a much more perfect fractionation, in a larger yield coupled with a superior quality of the distillates, especially of anthracene and of the residue, pitch. The still is fitted with a pipe at the top by which the vapours are carried into a condenser cooled by means of a water-jacket which is provided with a steam-coil so that the water may be heated at any stage as the distillation proceeds. The condensed products are run into different receivers. First come ammoniacal liquor and the light oils (if these have not already been got off by previous dehydration), which float on water. These are followed as the temperature rises by middle, heavy, and anthracene oils, which are

heavier than water. The residue left in the still is pitch, which, after it has cooled down to a temperature of 100-120°C, is run out into proper vessels where it cools and gradually becomes solid. If the fractions are to be made according to the indications of the thermometer fixed in the still, for example, while working without a vacuum, it is usual to change the receivers at the following points:—

1. Light Oil (also called Crude Naphtha) up to 170°C.
2. Middle Oil (also called Carbolic Oil) up to 230°C.
3. Heavy Oil (also called Creosote Oil) up to 270°C.
4. Anthracene Oil..............above 270°C.

These points are, of course, not always the same, for the temperatures in the distillation of coal-tar depend too much on the shape and size of the tar stills, on the way they are set and on the rate at which they are driven, and on the position of the thermometer-bulb in the still. A much more reliable method with a view to subsequent fractionation is the observation of the properties of the distillates. It is rather more usual in tar distillation practice to collect the various fractions according to the specific gravity of the distillates, which tend to rise in the proportion to the temperature of the distillation. Between which limits of specific gravity the various oils should be collected is a matter that depends on the particular products that are to be subsequently recovered from these oils. In the case of the last fraction, the anthracene oil, for example, the grade of pitch—hard, medium, or soft—required, mainly determines the limits of specific gravity, or alternatively, of temperatures between which this fraction is to be collected. All these figures have got to be worked out by the chemist in the laboratory prior to actual distillation of tar. It should be added in this connection that the different fraction enumerated above are not divided by any sharp lines substances occurring in the lower fractions may very often be present in small amounts in the higher ones, and conversely—and that at different works they are taken differently according to the market demand for products, and the ideas of the management concerned.

The yield of the several fractions as also of pitch varies within wide limits according to the kind of tar undergoing distillation. The yield from German tars (originating from coke-ovens) such as were found by the present writer in the course of his work are given below so that a fair idea as to the percentage content of the different oils obtained normally may be conveyed:—

Light Oil	..	0·5 2%
Middle Oil	..	8 —12%
Creosote Oil	..	6 —10%
Anthracene Oil	..	16 —25%
Pitch (medium grade)		50 —55%

Water and loss to distillation 5% approximately.

The residue left in the still, when coal-tar is distilled, is pitch, which usually makes up 50—55% by weight of tar. The hardness of pitch varies according to the total amount of oils distilled off from tar, and the greater this amount, the harder the pitch. The specific gravity of pitch depends upon its degree of hardness and even more upon the material from which the tar has been obtained. This varies from 1·25 to 1·44. The principal use of pitch is for the manufacture of patent fuel or briquettes from small coal or coke breeze. Pitch of medium grade is required for this purpose. Other uses of coal-tar pitch are in the manufacture of road tar of different specifications, for making electrodes, for obtaining soot, for making of special roofing materials and black varnishes. When pitch cannot be utilized in any other way, it can be burnt to lamp black or distilled for the purpose of making coke of particularly low ash-content. For purpose of street-paving the so called 'refined tars' are generally employed. Road tars of different specifications are made by allowing molten pitch to run into oil, preferably water-free heavy oil, or conversely, and by mixing the whole thoroughly by means of compressed air. Subsequent additions of oil or pitch may be necessary to bring the tar up to the specified viscosity, specific gravity, etc. In Germany, for example, road tar prepared by mixing 60% pitch and 40% anthracene oil is extensively used for the paving of roads.

The other process for manufacturing road tars, which is very often employed by the smaller tar distilleries, is to submit the crude coal-tar to a partial

distillation, say up to 230° or 240°C. The lighter oils are thereby taken out leaving the heavier oil fractions in the tar.

The next step consists in dealing with the several products of distillation of coal-tar. The primary distillation of tar, separation of the ammoniacal liquor and of the light, middle, heavy, and anthracene oils, constitutes merely the first step in a whole series of processes, and this by no means yields products which could be directly put to commercial use. In order to isolate valuable products—the various fractions are necessary. This normally consists in redistillation of the oils, crystallization, filtration, pressing of the crude products, washing and extraction by means of alkali and acid to remove the phenols, and bases and the unsaturated compounds respectively, and fractional distillation and rectification with the aid of efficient fractionating devices, and finally, if necessary, recrystallization of the pure products. The barest outline of the subsequent stages in coal tar distillation practice is all that can be given here.

The ammoniacal liquor is usually sent back to the gas-works or the coke-plant, or to a different department, as the case may be, to be worked up together with the liquor obtained at the latter place. Here ammonia is recovered and this by treatment with dilute sulphuric acid, is converted into ammonium sulphate which is extensively used as a fertilizer.

The "light oil" or crude naphtha is the first fraction that is given off by tar when distilled along with a certain amount of ammonia water. Almost the whole of this fraction is recovered in the form of the distillate when the tar is dehydrated. Ordinarily coal-tar contains only 0·5 to 2% of this oil, and as such it is worked up together with the crude benzol obtained from coal-gas at the gas-works or coke ovens. The light oil is a light, mobile liquid of yellow up to dark-brown colour, of specific gravity varying from 0·910 to 0·960, containing as its chief constituents 50-70% benzol and its homologues, toluene, xylenes, etc., and owes its commercial importance in the first place to the presence in it of these substances. Besides, it contains phenols (5-10%) and bases of the character of pyridine (1-3%), a certain amount of naphthalene (this is present in considerable quantity in light oils obtained from coke-oven tars), hydrocarbons of the paraffin and cyclo-paraffin series, and other substances.

The working up of light oils consists essentially in the manufacture of motor benzols of different specifications by the removal of phenols and bases and the more highly unsaturated hydrocarbons (but not entirely the less unsaturated compounds, such as ole-fines, since the presence of these is essential for imparting 'anti-knock' properties to the motor oils) by washing in turn with dilute caustic soda, dilute sulphuric acid and concentrated sulphuric acid, and finally, by fractional distillation in special stills heated by steam. The process of working up the light oil differs according to the product required. This is comparatively short if the object is to get motor benzols and longer entailing repeated fractional distillation if benzene, toluene, etc., in commercially or chemically pure form are worked for.

The middle oil, such as is obtained in the first distillation of coal-tar has a yellow up to light brown colour of specific gravity of 1·02, and contains up to 40% naphthalene, from 25 to 35% phenols (one-third of this being phenol proper or carbolic acid, and two-thirds the three cresols, and a little xylenol); further the two methyl-naphthalenes and about 5% bases, principally pyridine, quinoline, and quinaldine.

The working up of the middle oil is carried out differently in different factories. Either the crude oil is put into cooling tanks, in order to get out the naphthalene whereupon both the oil drained from the naphthalene and that obtained by pressing the crude naphthalene are redistilled, or the crude oil is distilled as it is without waiting for the napthalene to crystallize out. In the latter case the oil is split up into: *(i)* crude benzol up to the boiling-point 165°—this fraction is worked up together with the light oil; *(ii)* carbolic acid oil up to the boiling point 195°—this is worked up principally for phenol and naphthalene; *(iii)* napthalene oil up to the boiling point 220°—this is worked for naphthalene; and *(iv)* the residue remaining in the still may be employed for washing coal-gas to recover crude benzol in the gas-works and coke-ovens, or in the preparation of impregnating oil for pickling timber. From *(i)* and *(ii)* after crystallization and separation of naphthalene, the residual oils are worked up for phenols by extraction with dilute caustic soda solution, precipitation of the phenols by carbon dioxide gas, and fractional distillation and crystallization. The crude naphthalene is purified by pressing out the oils, washing in turn with dilute caustic soda, dilute sulphuric

acid and concentrated sulphuric acid, and by redistillation or sublimation.

The next heavier fraction of coal-tar distillation is the heavy oil, also called creosote oil, which has a specific gravity of 1·03 to 1·07. On allowing the oil to cool and stand about 20% by weight separates out in the form of a crystalline mass. This consists mainly of naphthalene and its homologues, in addition to thionaphthene, diphenyl, etc. Besides, the heavy oil contains a lot of phenols (10-15%) and bases (3-5%). The subsequent treatment of this oil consists in separating and purifying naphthalene, and recovery by redistillation of oils, which are partly used as such, *e.g.* washing oil (to extract crude benzol from coal-gas), and partly as starting materials for the manufacture of impregnating oils, fuel oils for Diesel engines, etc. The heavy oil is very often worked up together with the middle oil in order that the phenols and naphthalene contained in both of them may be collected together.

The last fraction of coal tar distillation, the anthracene oil (also called green oil), is a greenish viscous oil of a specific gravity of about 1·1, and consists of the highest boiling portion of coal-tar.

The working up of this oil consists essentially in the separation of the solid from the liquid portions. On allowing anthracene oil to cool and stand, crude anthracene separates out in the form of a greenish crystalline paste, which is filtered off, pressed, and washed free of oil by means of a little solvent naphthalene (derived from the light oil). The anthracene thus purified is used in the manufacture of anthraquinone from which as the starting material, alizarine and other exceedingly fast dyes for cotton are obtained. From the solvent extract from the anthracene paste, phenathrene and carbazole are recovered. The oils drained from the crude anthracene are employed as lubricants, or are redistilled and split up into fuel oil, impregnating oil, and lubricating oil. The lubricants obtained from coal-tar oils are, of course, inferior to such products derived from petroleum, but not so are the impregnating oils from tar-oils, which are superior to those obtained by distilling wood-tar.

The present writer obtained the following yields of pure products from a representative sample of German tar:—

Benzene (Benzol) and Toluene	0·22% of tar
Xylenes and Solvent Naphtha	0·62% „ „
Phenol	0·40% „ „
Cresols	6·35% „ „
Naphthalene	6·35% „ „
Anthracene (pure)	0·42% „ „

The chief applications that are made of the more important commercial products recovered from coal-tar may now be summarized. These are given below:—

	Crude or nearly pure	Pure
Benzene	As Motor Fuel, Solvent,	In the manufacture of Dyestuffs; Solvent
Toluene	Solvent	In the manufacture of Dyes, Explosives, (T. N. T.), Saccharine.
Xylenes	Solvent	In the manufacture of Dyes, Synthetic Perfumes
Naphthalene	Insecticide, and mild disinfectant, and for the manufacture of lamp-black.	In the manufacture of Dyes
Phenol	Strong antiseptic and disinfectant.	In the manufacture of Dyes, Explosives, Synthetic Drugs, Artificial Resins (*e.g.* Bakelite, Resinite).
Cresols		
Pyridine		For denaturating spirit as a reagent in the laboratory.
Anthracene		In the manufacture of the fastest cotton dye-stuffs.

Although no definite line can be drawn setting the limit up to which the tar-distilleries could go, it has up till now been more or less usual for them to stop at the point of manufacturing the above-mentioned products in pure form. The preparation of the intermediate products required in the manufacture of the industry of dyestuffs, pharmaceutical products, etc, and the manufacture of the latter substances themselves from these coal-tar products as the starting materials form separate industries by themselves.

which, however, are dependent on the main industry of coal-tar distillation.

Coal-tar distillation, by virtue of the immense possibilities it offers, is one of the most important chemical industries almost on a par with those of sulphuric acid, caustic soda, and industrial alcohol. From all the information available it appears that we in this country are not at present utilizing all the tar we produce in the way it should be done. The growing iron and steel industry would require as a matter of necessity increasingly greater output of hard coke, which in its turn would naturally result in greater quantities of tar being made available. In view of this, it behoves all those interested in the industrial development of India to seriously think of the problem of utilizing coal tar in ways other than burning it in the crude state or running it to waste, or exporting it abroad. The last-named course would be tantamount to allowing a most important source of potential wealth to flow out of this country.

It is true in the present circumstances in the face of terrible competition in tar products of every description from countries that are industrially ahead of us—some of them have even been allowed to enjoy preferential treatment over others in the matter of tariff, etc., it would not at all be easy for us to successfully hold our own without the active support of the Government of this country. Whether such cooperation would be forthcoming from the Government is a question that may be left over for discussion at a later stage. But what is important in the first place is to focus attention on the urgency of the problem and to secure its general recognition. The efforts SCIENCE AND CULTURE has been making in this direction with great energy and zeal ever since its inception would, it is to be expected, help materially in securing this end.

Tantalum

From the mineralogical point of view tantalum is closely associated with niobium, the oxide of which was isolated by Hatchett in 1801 from columbite. Two years later Ekeberg discovered tantalic acid in columbite of Finland. But it required more than a century before this element found industrial application, that is to say, after Bolton in 1903 was able to give it a ductile form. The thin filaments of tantalum were employed in Germany up till 1911 for incandescent glow lamps, and Germany had practically the monopoly of it. Even now tantalum filaments are p~~repared~~ to all other metallic filaments in cases where the lamps are subjected to strong vibrations.

The old process of extraction of the metal by the reduction of double fluorides by sodium has been replaced now-a-days by the electro-deposition from a bath of f~~u~~ fluorides. The mineral fused with caustic soda gives a soluble tantalate from which the oxides are precipitated with sulphuric acid. The mixed oxides are dissolved in hydrofluoric acid and the solution allowed to crytallize with the addition of potassium fluoride. The sparingly soluble nature of K_2TaF_7 permits to separate tantalum from niobium. It was only in 1910 that the electrolysis of fused fluotantalate was for the first time applied. Anode of impure tantalum and a cathode of tantalum foil were used. Later on a process analogous to that used for aluminium extraction was adopted, i.e., Ta_2O_5 was added to the fused bath of double fluoride.

Tantalum is mainly characterized by its resistance to chemical agents, even to *aqua regia*. In America it is commonly used for laboratory utensils and even for the preparation of standard weights. Tantalum finds extensive use in the construction of acid-resisting apparatus, in the manufacture of electrical rectifiers and as an antifriction metal. It is equally precious for the fabrication of surgical instruments and is used in dertistry and jewellery; an irredescent surface can be obtained by electrolysis.

Tantalite is less common in India than columbite. It occurs with columbite at Pananoa Hill, Monghyr, Bihar. It is not exploited in India.

P. B. S.

Research Notes

Magnetic Disturbances during a sudden Chromospheric Flare from the Sun

In a previous note to this section of the SCIENCE AND CULTURE (Vol 3, p 115, 1937) the readers of this journal were informed of a number of, more or less world wide, disturbances occurring on earth practically simultaneously with a solar outbrust marked on the sun's limb by a remarkable brightening of the H-alpha light in the region of a large sunspot. These terrestrial disturbances are (1) world-wide radio fade outs, (2) Sudden changes in the Earth Currents, (3) Sudden variation of the earth's magnetic field. This disturbance of the earth's magnetic field was interpreted to be what is commonly known as the magnetic storms. In two recent papers, one appearing in the *Terrestrial Magnetism* (Vol 42, p 109, 1937) and the other in the *Physical Review* (Vol 52, p 155, 1937), A. G. McNish after a detailed study of the magnetic effects associated with the solar outbursts concludes that these outbursts do not produce "magnetic storms" but result in a very special type of magnetic effect different in nature from those occurring during magnetic storms.

The sudden magnetic disturbance accompanying a solar flare is distinct from the phenomena of magnetic storms by the facts (1) that the former is more or less simultaneous with the solar flare and disappears always with the disappearance of the solar phenomena, whereas magnetic storms are related to solar activity in a statistical sense only and, whenever they occur, persist for a day or more; (2) that it is not world wide, being confined to a region less than 90° from the subsolar point at a time of occurrence, on the other hand magnetic storms are most strongly manifested in polar regions; (3) that the changes in vertical intensity of the magnetic field caused by the solar eruptions are small as compared with the changes in horizontal components whereas during a magnetic storm no such hard-and-fast rule is obeyed. These facts indicate that the pronounced but short-lived jump in the magnetic records coincident with the flare, cannot be regarded as a magnetic storm.

The cause for the magnetic disturbance on the surface of the earth is believed to be somewhere very high up in the ionized upper atmosphere. Stewart-Schuster theory says that the diurnal variations of the earth's magnetic field are caused by currents produced by the electromotive force generated by the movements of the conducting ionized upper atmosphere across earth's permanent magnetic field. Intense ultraviolet light from a solar flare may cause a sudden increase in these currents. It is concluded from various diagrams that the special disturbances accompanied by a solar flare do not arise from irregularities in ionization but from irregularities in the distribution of electromotive forces producing the "ionospheric winds."

The electric circuits present in the upper layers of the atmospheres must be of very great dimensions. From the rapidity of changes occurring in these circuits as manifested in the sudden appearance and equally sudden disappearance of magnetic disturbances it is concluded that the reactance of these circuits is neglible.

S. C. DEB.

An Egyptian Mirror Handle in Fossil Bone

A note on this is published in *Man*, July 1937 by D. E. Derry of Cairo. He says that in 1922 and 1923 at the time of excavating Gau of Upper Egypt, Mr G. Brunton opened a burial pit of the First Dynasty in which petrified animal bones mainly of hippopotamus, fragments of three human skulls and other bones of the skeleton are found mineralized. The pit contains Eighteenth Dynasty curved ivory objects, mirrors, spoons etc. Derry was curious enough to go through the whole collection with the idea of finding out

whether any of them showed signs of having been used as material in the manufacture of such articles as those found in the pit. But he could not find out any such things. Soon after the return of Derry to Cairo, Major R. G. Gayer-Anderson showed him the broken half of a mirror handle which 'proved to have been fashioned from the petrified bone of some animal.' In the miror handle the cancellous tissue of the bone is well marked.

M. N. B.

A new High-tension Plant for Atomic Disintegration

1. A systematic study of the nuclear disintegration of atoms necessitates the production of very high speed projectiles.

2. For a long time, however, such high speed particles could not be *produced,* but only could be *obtained* from radioactive substances like Radium, Polonium, etc. which emitted fast α- particles (Helium atom shorn of its electrons) having the requisite amount of energy for nuclear transformation. This was a great draw-back in the experimental study of nuclear transformation, since the motion of the ejected α- particles from a radioactive body is beyond human control and the particles emitted are comparatively few in number. Lord Rutherford, however, drew attention to the idea, that if the α- particles were replaced by very high speed electrons accelerated by intense electric field the motion of the projectitles could be easily brought under control. Rutherford, Cockroft, Walton and many others strove hard for practically applying this idea and succeeded to some extent. They developed the so-called impulse generator method in which a high voltage could be maintained for brief periods lasting about a few millionths of a second; this was no doubt a great improvement over the older method of employing "natural" α- particles, but it had a very serious limitation in as much as it was not suitable for producing a steady beam of high speed projectiles.

3. Thanks, however, to the long and strenuous labour in the high voltage research laboratories of great manufacturing organizations, it has recently been possible to build up suitable high tension plants which would generate very high direct-current potential. The feat is no doubt marvelous and its achievement, even a few years back used to be regarded as impossible. This exceedingly high difference of potential can now be effectively applied for accelerating electrically charged particles (say, electrons) to a sufficiently high speed; these particles, when injected into the nucleus of an atom will disintegrate it and transmute it to atoms of other elements. Such a plant generating 1¼ million volt was some time ago installed in Lord Rutherford's Laboratory at Cambridge by the Philips Radiological Laboratory. Recently Philips Radiological Laboratory announce that they have been able to develop a high-tension plant which would generate upto 4 million volts.

4. The great advantage of this method is that it provides us with a mechanical control over the velocity of the projectiles, by varying the generated voltage. Moreover, the beam of projectiles is much more intense in this arrangement than in other prev[illegible]ethods.

5. The [illegible] and research by technicians [illegible] of manufacturing firms lik[illegible]s, which have been responsible in de[illegible] these plants, have not only given an impetus to an intimate study of the atomic nucleus but have also led to therapeutic studies of great value. Curie and Joliot have shown that a radio-active substance can be produced artificially by the bombardment of the nuclei with high speed projectiles. But this is very feeble; the recent development of the high tension plant will however greatly help the production of the artificial radioactivity and increase its possible medical and therapeutic applications.

S. B. B.

University and Academy News

The Indian Science News Association

The third annual meeting of the Indian Science News Association was held on August 29, 1937 at 4-30 p.m. in the Applied Chemistry Department, University College of Science, Calcutta. Owing to the unavoidable absence, due to illness, of Mr S. P. Mookerjee, Vice Chancellor, Calcutta University, Dr Baini Prashad presided over the meeting.

The Secretary, Prof. S. K. Mitra, reviewing last year's work described the services rendered to the country by "SCIENCE & CULTURE" through its editorial and other articles on national problems by eminent authorities on the subject. He referred to the introduction into the journal of the section of "Science in Industry," which is now a regular feature containing every month an article on an important industrial subject. He then submitted the report of the Association for 1936-37.

Prof. M. N. Saha, one of the Secretaries of the Association, then delivered a short speech in regard to the work so far done by SCIENCE & CULTURE, the object of which was not only popularization of scientific knowledge, but also to advocate the application of science to all problems of our national reconstruction. It was held in some quarters that the schemes advocated in the journal were too ambitious and expensive. Dr Saha cited the example of Soviet Russia which in its pre-Revolution days was similar to India in her potential plenty and undeveloped natural wealth and resources. No scheme of national reconstruction could be pushed to a successful end due to conflict with the vested interests created by the capitalist system. But the Soviet Russia realized the importance of the co-operation and service of the scientific talent of the land for the purpose of an all-round development and enlisted it. The magnificent results of this are now before the world as instances of admiration and emulation. The enormous development of Russia should give food for thought to all our politicians. "If all the national development schemes, concluded Dr. Saha, which have appeared in SCIENCE & CULTURE can be carried out---and it depends upon those who hold the power, then the problems of poverty, flood, famine, and pestilence, which have become chronic in our unfortunate country, will disappear for ever."

In his presidential remarks, Dr. Baini Prashad said that there was a great truth in Prof. Saha's advocacy of having non-official co-operation for such schemes where the advice of scientists would be of value. SCIENCE & CULTURE had in the past done good service by publishing detailed articles regarding a number of scientific schemes which would be of great value for the advancement of the country, and it was hoped that more detailed information regarding such schemes would be published in the future issues.

Botanical Society of Bengal

The Fourth Ordinary General Meeting of the above Society was held on Monday, the 30th August, 1937, at 5-30 P.M. in the Botanical Laboratory, Presidency College, Calcutta, to transact the following business:—

I. Confirmation of the minutes of the 3rd Ordinary General Meeting held on 30-7-37.

II. The following paper was read:—

"A new aspect of nitrogen fixation in Soil"

by—S. R. Sen Gupta, M.Sc., Ph.D. (Lond.).

Letters to the Editor

A new Micro-chemical Method for the Confirmation of the Molecular Formulae of Stenones, especially of Artostenone

Sterols or stenones contain in general a large number of carbon atoms per molecule and the task of ascertaining definitely the exact number of carbon atoms present in such a molecule is a very difficult one. It was decided only in the year 1932 that the formulae for ergosterol is $C_{28}H_{44}O$ and not $C_{27}H_{42}O$. A sufficient quantity (about 20 gr.) of the substance was also necessary for such determination.

Isolation and investigations on the constitution of a new stenone "Artostenone" has just been reported by the author.[1]

By way of determining definitely the actual number of carbon and hydrogen atoms in an artostenone molecule it has also been possible to develop a new micro-chemical method which may with great advantage be applied to any sterol or stenone.

A short note of the method is given below. Details will shortly be published elsewhere.

Artostenone has been converted to an amine artostenamine (m. p. 169°—170°) through its oxime [*i.e.* by reducing the oxime with zinc dust and alcoholic solution of caustic soda (5%)]. This amine is insoluble in HCl but soluble in glacial acetic acid. Two molecules of this amine combine with one molecule of H_2PtCl_6 to form a complex artostenamine platinichloride. The molecular weight of this complex has been found to be .291 (Pregl's micro-muffle method). From this the mol. wt. of artostenone on calculation comes out to be 440.5 ($C_{30}H_{50}O$ requiring 426 as the mol. wt.).

Confirmation of the molecular formula of artostenone (the determination of the exact number of carbon and hydrogen atoms in the mol) has been possible through the micro-analytical determinations of carbon and hydrogen of this heavy Pt complex. The percentage of carbon and hydrogen as ascertained by micro method, is 56.88 and 8.5 respectively.

$(NH_2C_{30}H_{50}HCl)_2\,PtCl_4$ requires 57.05 and 8.1

Difference of one carbon or hydrogen atom in the molecule would cause a large variation in the percentage of carbon and hydrogen of the complex Pt-compound. Hence only by combustion it is possible to ascertain definitely the number of carbon and hydrogen atoms in the large mols. like sterols and stenones. ·2 gr. substance is sufficient for the determination.

The author records his thanks to the Lady Tata Memorial Trust for a research grant.

Thanks are also due to Prof. J. C. Ghosh and Dr K. P. Basu for the facilities offered and for the interest they have taken.

Chemical Laboratory,
Dacca University. M. C. Nath.
13.7.37.

1. Nath, M. C. - Hoppe *Seyler's Z. Physiol, Chem.* *247*, 9, (1937); SCIENCE & CULTURE, *3*, 57, 1937.

The Determination of Iso-electric Point of the Neurotoxin of the Russell Viper Venom

The determination of the iso-electric point of the neurotoxin of Russell Viper venom was carried out in a three-chambered glass cell, the middle chamber being separated from the two side chambers by membranes of suitable porosity. The venom solution adjusted to requisite pH was placed in the middle chamber and the side chambers were filled with buffer solutions having the same pH as that of the solution in the middle chamber. The side chambers were put into electric connection with copper sulphate solutions contained in two beakers by means of agar bridges. Two copper electrodes were dipped into the copper sulphate solutions contained in the two beakers. The whole arrangement was placed inside a refrigerator maintained at 4°C. After passing 108 coulombs of electricity through the system the contents of the two side chambers were tested. It was found that the neurotoxin can pass through "ultrafine coarse" membranes but are completely held back by "ultrafine medium" membranes. Using "Ultrafine coarse" membranes the toxicity of the contents of the cathode and the anode chambers were found to be the same at pH 5.8 to pH 5.9. The iso-electric point of the neurotoxin is in the

neighbourhood of pH 5.8. It will be evident from the following data in the table

pH	Nos. of m. l. d, s in Cathode.	Anode.
3.0	300	"
4.0	350	"
4.5	300	"
5.0	150	10
5.4	50	10
5.6	20	12
5.8	10	10
5.9	10	10
6.4	10	50
7.0	"	120
8.0	"	180
9.0	"	240

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Calcutta.
8. 10. 37

B.N. Ghosh.
S.S.De.

Partial Separation of the Neurotoxin of Russell Viper Venom

The dried venom of Russell Viper has been analysed by Ganguly and Malkana (1935) and has been found to contain as much as 96.8 per cent protein. The neurotoxin is always associated with the protein portion of the venom Measured by intravenous injection into pigeons, there are usually present 688 M L.D. of neurotoxin per mg. of N_2 of the dry venom. Ganguly and Malkana obtained a preparation which for the same nitrogen content, was 1.7 times richer in neurotoxin than the original venom. We have, however, succeeded in concentrating the neurotoxin in a protein fraction, which for the same nitrogen content is about 5.1 times richer in neurotoxin than the original venom. The procedure adopted by us is as follows. To 20 c.c of a 0.5 per cent solution of Russell Viper venom (pH 5.8) was added 30 c.c. of 40 per cent sodiun sulphate solution (pH 5.8). The mixture kept at 37°C for 30 minutes and then centrifuged. The supernatant solution containing the neurotoxin was taken and to it was added solid sodium sulphate until its concentration in solution was 30 per cent. The precipitate contains the major portion of the neurotoxin. It was separated by centrifuging, dissolved in water and the volume made up to 50 c.c. The solution was then shaken with Willstatter's aluminium hydroxide C (12 mg of aluminium hydroxide was used for every 1000 M.L.D. of venom) for 30 minutes. The gel was separated by centrifuging and was then shaken with a solution containing 1 per cent Na_2HPO_4 and 1 per cent glycerine for 30 minutes for the elution of the neurotoxin. The toxicity and nitrogen content of the solution were then determined. It was found to contain 3500 M.L.D. per mg. of N_2. Therefore purification attained is 3500/688 i.e., about 5.1 times.

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8. 10. 37.

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S. S. De.
D. P. Bhattacharjee.

On the Occurrence of *Camallanus anabantis* Pearse 1933 in an Indian edible fish

The nematode worm *Camallanus anabantis* was first described by Pearse[1] in 1933 from the intestine of the fish *Anabas testudineus* at Bangkok, Siam. Literature on the subject shows that *C. anabantis* has not been reported from India, and incidentally this is the first report on the occurrence of this worm in India. In course of examination of the gut contents of the same fish nine specimens of nematode worm were encountered, which on examination proved to be *C. anabantis*. Though identified as *C. anabantis* these specimens exhibit differences from the description given by Pearse. The description by Pearse is insufficient, and therefore, a detailed description of this worm would be published later on.

Department of Zoology,
University of Calcutta.
7. 10. 37

Girindra Kumar Chakravarty.

1. Pearse, A. S *Journ. Siam. Soc.* 9, 182-183. 1933

On the Intensity Variation of the Auroral Green Line of the Night Sky Light.

A number of workers[1] have reported that the intensity of the oxygen line 5577.35 Å ($^1S_0$-$^1D_2$) undergoes gradual increase after sunset, reaches a maximum value some time after midnight and gets weaker again before dawn. There is a certain correspondence between this phenomenon and the variation of the height of the F-layer throughout night. Thus the F-layer persisting at a constant height of about 300 km for some hours after sunset gradually approaches a minimum level (c. 200 km) after midnight and again goes up before dawn[2]. It has also been estimated that the green line 5577.35 Å in the night sky originates at a height between 200 km and 300 km above

the surface of the earth.[3] Assuming that the number of radiating O-atoms remains fairly constant throughout the night, the approach of the F-layer towards the ground signifies that the radiating centres are brought nearer to the earth, and the recession of the layer, on the other hand, results in the removal of the radiating centres farther away. If, now, the layer descends by some 80 km from the maximum height of about 300 km, an application of the inverse square law gives the ratio of the maximum intensity to the minimum of the green line to be roughly 2:1, as found experimentally. It is interesting to note in this connection that the electron density of the F-layer assumes a maximum value near about the midnight[4] when also the intensity of the green OI line 5577·35 attains its maximum value.

Indian Association for the
Cultivation of Science, B. Mukhopadhyay.
210, Bowbazar Street, Calcutta.
2. 10. 37

1. Rayleigh, *Proc. Roy. Soc* *124*, 395, 1929; Mc. Lennan, Mc Leod & I eton, *Trans. Roy. Soc.* Can, *22*, 307, 1928; Dobrotin, Franck, Cervenkov, *Comtes Rendus. U. S. S. R. 1*, 110, 1935;
2. Martyn and Pulley, *Proc. Roy. Soc. 154*, 455, 1936.
3. Cabannes, *Comptes Rendus*, *200*, 1905, 1935.
4. Appleton and Naismith, *Proc. Roy. Soc.*, *160*, 685, 1935.

Interpretation of the Absorption Spectra of Pr IV

The sharp absorption spectra shown by the rare earth ions in solution as well as in crystals have led to the view that they originate in the inner transitions within the (5s,p) shell. Van Vleck[1] has recently shown that their sharpness and the extremely low intensity are explicable if they are attributed to the forbidden transitions, which are due to the rearrangement of the l-and s-vectors of the 4f electrons. He has enumerated three forms of radiations possible in such cases, viz.,

(1) Quadrupole radiation, where ΔJ or $\Delta L = \pm 2, \pm 1$ or 0
(2) Magnetic dipole „ „ „ $= \pm 1, 0$
(3) Electric dipole „ „ „ may be up to ± 4,

(Caused by the distortion in the motion of electron brought about by the asymmetry in the crystalline field).

The purpose of the present note is to attempt a classification of the absorption spectra of Pr IV in the light of the above theory.

In Pr IV containing only two 4f-electrons the various allowed states are given by ^{3}(P, F, H) and ^{1}(S, D, G, I); of these $^3H_4$ represents the ground state. The different groups of sharp absorption lines and bands will thus arise out of electronic transitions from the ground state ot the other allowed states. The fine structure inside each group is due to the decomposition of the energy levels in the crystalline field and to their coupling with the lattice vibrations. It is therefore regarded that the centre of gravity of each group denotes the frequency of the corresponding electronic transition in the absence of any field.

The spectral terms of Pr IV will be analogous to those of La II, which possess the electronic configuration $4f^2$. In the present classification it is therefore proposed to take the help of the analysis of the emission spectra of La II carried out by Meggars and Russell. In it the terms corresponding to the allowed states due to $4f^2$ configuration are all present. It is possible to calculate the values of the terms of Pr IV from those of La II. The difference in the two cases lies in the different values of their effective nuclear charges. The intervals between the terms will therefore differ by a constant factor. From the separations between the components of the ^3H multiplet it is found that this factor is 2·41 approximately. In the table I the values of the allowed terms of Pr IV calculated from those of La II are given. The ground term $^3H_4$ is assumed to be at zero. The C. G. s of the groups of observed lines and bands are placed side by side, so that the corresponding transitions are quite apparent.

TABLE I.

Terms.	'J'	Termvalues (Calculated)	C. G.s of absorption groups (observed)
^3H	4	0 m^{-1}	
	5	2,100 „	
	6	4,154·4	
^3F	2	5,500·8 „	5200* m^{-1}
	3	6,746·4 „	6950* „
	4	7,564·8 „	
^1G	4	10,608 „	9835* „
^1D	2	11,740·8 „	
^1I	6	17,522·4 „	17,043 „
^3P	0	20,066·8 „	20,602 „
	1	20,390·4 „	21,294 „
	2	22,012·8 „	22,401 „

The absorption spectra in the visible region were investigated by using large single crystals of $Pr\,cl_3, 7H_2O$. The frequencies in the infra-red (marked with an asterisk) are taken from the data of Gobrecht[2]. It will be noticed in the table that there is a close agreement between the observed and the calculated frequencies. A detailed account of the investigation will appear later in the Indian Journal of Physics.

Palit Physical Laboratry, P. C. Mukherji.
University College of Science, Calcutta.
30. 10. 37.

1. Van Vleck. *Journ. Phys Chem*, *41*, 64, 1936.
2. Gobrecht. *Ann. des Phys.*, *28*, 673, 1936.

Obituary

Lord Rutherford of Nelson

It is an irony of fate that we have to write the obituary of Lord Rutherford instead of having the privilege of printing his Presidential Address to the Silver Jubilee of the Indian Science Congress. A true scientist is usually absorbed in his work in the laboratory, and Lord Rutherford was the living illustration of this rule. In fact it was with the greatest difficulty that he was persuaded to accept the presidentship of the Jubilee session. He wished to be excused on the plea that he had no first-hand knowledge of the problems of Indian Science. But, as a recent Indian visitor to the Cavendish Laboratory narrated to one of the writers, having accepted the presidentship, he had begun the study of Indian problems with great enthusiasm, and our friend thought that his lecture would not only have been a great contribution to science, but would have proved also very useful for future. His sudden and unexpected death has cast a gloom over the whole of scientific India.

Early Career

Lord Rutherford of Nelson was the son of middle-class parents in New Zealand, being the youngest child of a large family. He was early educated in the city of Nelson and one of his class-fellows was Sir William Marris, ex-Governor of the United Provinces. After a brilliant career in New Zealand, where he carried out researches on his own account in the then exciting subject of wireless telegraphy, Ernest Rutherford, as he was then, came to England in the year 1895 to do research work at the Cavendish Laboratory under Prof. Sir J. J. Thomson (now Master of Trinity College, Cambridge). Thomson records in his autobiography that three of his most prominent students arrived on the same day at the Cavendish Laboratory from different parts of the world, Rutherford from New Zealand, McLennan from Canada, Townsend from Trinity College, Dublin. Many of Thomson's pupils rose to great distinction but, of course, none to the height which Lord Rutherford reached. His coming to England was rendered possible by the award of an 1851 Exhibition Scholarship.

Lord Rutherford of Nelson.

Career at the Cavendish Laboratory

While in New Zealand, Rutherford had made experiments on the effect of High Frequency Di-

charge on the Magnetism of Iron, which led to his invention of the Magnetic Detector of electric oscillations. These experiments were continued at the Cavendish Laboratory, and established a record for long-distance telegraphy at that time. However, this work was soon given up for that of a more fundamental nature. Thomson was busy at that time with investigations on the ionization of gases produced by the newly discovered Röntgen Rays (1893). He impressed into service all the younger workers in the Laboratory, Townsend, McLennan, Langevin (from Paris), and Rutherford. Rutherford entered the new work with extraordinary enthusiasm and very soon discovered several results of great importance. In 1897, he showed that there is a close connection between the absorption of X-rays and the amount of ionization produced, that the rate of recombination of ions is proportional to the square of their number present, and by a special method determined the sum of the mobilities of the positive and negative ions in the case of many gases. In 1898 he took up the study of the emission of electricity from metals illuminated by ultraviolet light and soon proved that the ions produced by ultraviolet light were identical with those produced by X-rays.

Radio Activity

After these preliminary works, which were carried on during the period of his apprenticeship to Thomson, Rutherford passed on to what was destined to be his life-work. In 1895, Röntgen had discovered the X-rays, and the unusual properties possessed by these rays created the most intense interest in the world, and led scientific men to look for 'hidden rays' from all kinds of sources. One of the men who were rewarded with a great discovery was H. Bequerel of Paris who found that the heavy element, Uranium, or any of its compounds, emitted "rays" which could pass through paper and effect photographic plates. Following up the work of Bequerel, the Curies discovered the wonderful element, 'Radium,' after an epic struggle, and other 'radio-active elements' were soon discovered in succession by Schmidt, Debierne, and others. But the properties of these elements were a complete puzzle to the physicists. They were found to emit radiations which could not be modified by the most severe chemical and physical treatment, got spontaneously heated, and apparently were able to induce similar properties in substances held close to them. An idea of the confusion which reigned in the minds of the greatest scientists may be gathered from the following extracts from Rutherford's *Radioactive substances and their Radiations*—published in 1913.

J. Perrin, in 1901, following the views of J. J. Thomson and others, suggested that the atoms of matter consisted of parts and might be likened to a miniature planetary system. In the atoms of the radio elements, the parts composing the atoms more distant from the centre might be able to escape from the central attraction and thus give rise to the radiation of energy observed.

"P. Curie, who in conjunction with Debierne, had made a series of researches on the radium emanation, did not at first consider that their was sufficient evidence that the emanation was material in nature. He suggested that the emanation consisted of centres of condensation of energy attached to the gas molecules and moving with them.

"In a paper announcing the discovery of the heat emission of radium, P. Curie and Laborde state that the heat energy might be equally well supposed to be derived from a breaking up of the radium atom or from energy absorbed by the radium from some external source.

"J. J. Thomson in an article on "Radium," communicated to *Nature*, put forward the view that the emission of energy from radium was probably due to some change within the atom, and pointed out that a large store of energy would be released by a contraction of the atom.

"Sir William Crookes, in 1899, proposed the theory that the radio-active elements possessed the property of abstracting energy from the gas. If the moving molecules, impinging more swiftly on the substance, were released from the active substance at a much lower velocity, the energy released from the radio-elements might be derived from the atmosphere. This theory was advanced again later to account for the large heat emission of radium, discovered by P. Curie and Laborde.

"F. Re advanced a very general theory of matter with a special application to radio-active bodies. He supposed that the parts of the atom were originally free, constituting a nebula of extreme

tenuity. These parts had gradually become united round centres of condensation. and had thus formed the atoms of the elements. On this view an atom might be likened to an extinct sun. The radio-active elements occupied a transitional stage between the original nebula and the more stable chemical atoms, and in the course of their contraction gave rise to the heat emission observed.

"Lord Kelvin in a paper to the British Association Meeting, 1903, suggested that radium might obtain its energy from external sources. If a piece of white paper is put into one vessel and a piece of black paper into an exactly similar vessel, on exposure of both vessels to light the vessel containing the black paper is found to be at a higher temperature. He suggested that radium in a similar manner might keep its temperature above the surrounding air by its power of absorbing unknown radiations.

"Armstrong and Lowry in 1903 suggested that radio-activity might be an exaggerated form of phosphorescence or fluorscence with a slow rate of decay."

It was at this stage, that Rutherford entered the field. His debut was very modest.(He started in 1899 by examining the conductivity produced in gases by Uranium Rays. He showed by absorption experiments that the Uranium rays consist of at least two distinct kinds of rays, which are now known as α- and β-rays.) The experiments with Thorium, another radio-active substance, however, gave rather uncertain and discordant results—and the cause of this was not at all clear at that time, but it was further in persuance of these results which led to the first rational understanding of radio-activity.

Rutherford in Canada

(Rutherford now left Cavendish Laboratory to take up the position of Professor of Physics in the McGill University, Montreal, Canada, where he stayed up to 1907. Here he continued the investigation of the cause of the discordant results obtained with Thorium and was ultimately led to the discovery of the thorium emanation, and later in collaboration with Soddy to the theory of successive and spontaneous disintegration of elements.) This theory which he presented to the world in 1903, has remained the corner-stone of the new science of radio-activity and in the hands of himself and his pupils led to complete elucidation of this phenomenon. (Rutherford returned to England in 1907 as Professor of Physics in the Manchester University, and started his second group of works on the structure of the atom which was the logical development of his work on radio-activity carried at Montreal. In 1903 he was elected to the fellowship of the Royal Society and in 1908 he was the recipient of the Nobel Prize for Chemistry for his theory of successive disintegration of elements,) mentioned before. It was a surprise to Sir J. J. Thomson and other distinguished physicists as the award was made on chemistry, and not on physics.

Rutherford at Manchester. The Nuclear Theory of the Atom

Under Rutherford's guidance the Physical Laboratory of the University of Manchester rose to be one of the foremost centres of research and attracted students not only from England, but from Germany, Denmark, Russia, America, India, and many other countries of the world. The scientific world at this time was very sharply divided on the question of the structure of the atom. Ever since the discovery of the electron in 1895, and of the recognition of the fact that it formed a universal constituent of all matter, the older ideas regarding the atom as an ultimate constituent of matter which was not further divisible, became untenable. Physicists began to speculate about the way in which the atoms of positive and negative electricity were combined to form the different kinds of atoms. The first suggestion came from the famous physicist, Lord Kelvin and was further elaborated by Sir J. J. Thomson. They held that the positive electricity was concentrated in a sphere of about the same dimensions as the atom, and the electrons were uniformly distributed throughout the sphere. But, under Rutherford's guidance, two of his pupils, Geiger and Marsden, performed a fundamental experiment to test Thomson's hypothesis. They bombarded the atoms with high-velocity α-particles and found that though in general the largest number of α-particles were deflected according to Thomson's hypothesis, a very small number were returned on the same side from which the particles were projected.) A less careful

man than Rutherford would have imputed the slight deviation to experimental error, but Rutherford knew his apparatus and would not take that view. He showed that the results could only be explained if it was assumed that the positive electricity was confined in a very small region (about 10^{-4} times the atomic radius) at the centre of the atom (called the nucleus). Further experiments led to complete confirmation of his views, and in 1911, he formulated the nuclear theory of the atom in opposition to the Thomson model. It may be mentioned here that similar views had already been advocated in 1904 by the Japanese physicist, Nagaoka and the German physicist, Lenard, from his study of the passage of electrons through matter, but Lenard's language was too difficult for easy comprehension.

Bohr's Theory of the Hydrogen Atom

Support for this theory, which is now universally accepted and forms the corner-stone of atomic physics, came from many quarters. About this time (1911) Niels Bohr, a young Danish scholar, (born 1885) had been also studying the passage of β-particles through matter and had arrived at the same views as Rutherford. He came to England with a scholarship, but very few physicists in England were prepared to listen to such heretical views. But Bohr found a sympathetic response in Rutherford, who was so much impressed with the originality of Bohr's mind that he created for him a readership in the Manchester University. Here, in the sympathetic atmosphere, Bohr worked out his famous theory of the origin of the hydrogen spectrum. It was a brilliant synthesis of the ideas underlying the nuclear theory of the atom, and the quantum theory of light advocated by Planck (1900) and Einstein (1905) in Germany, and provided a key, with which Bohr, his pupils and other physicists notably Sommerfeld and his pupils gradually unravelled the structure of all kinds of atoms and gave an explanation of their spectra as well as their chemical and physical properties.

Another distinguished man of the Manchester School was Geiger, the German physicist, who under Rutherford's guidance invented the Geiger counter, which is indispensable for researches in nuclear physics and cosmic rays. It was also under Rutherford that Moseley, killed during the Great War in the Dardanelles, made his brilliant investigations on characteristic X-ray spectra and their relation to atomic number.

Rutherford at the Cavendish Laboratory

In 1919, Sir J. J. Thomson was elected master of the Trinity college, and retired from the chair of the Cavendish Laboratory. It is said that he expressed a wish that Rutherford *as the most distinguished of his pupils* should be asked to fill up *the most distinguished chair of physics in England*, filled up previously by such giants as Maxwell and Lord Rayleigh. Accordingly, Rutherford joined the Cavendish Laboratory in 1919 as Cavendish Professor, and began his third great series of investigations. It was characteristic of Lord Rutherford that he was always for opening new fields leaving the old one opened by him for fuller exploration by others. Up to this time the nucleus had been regarded much as the old atom, merely as a lump of mass with positive charges on it. Rutherford clearly foresaw that the nucleus would be as much as, if not more, complicated than the atom and began to devise experimental technique for a frontal attack on its constitution. In 1919 he bombarded nitrogen with high-speed α-particles and obtained from it the nucleus of hydrogen, which he christened as proton. This was the first example of conversion of an element into another (*Transmutation of Elements*), thus taking the first practical step towards the alchemist's dream of converting base metals into gold. Along with his pupils, he performed many fundamental experiments for the elucidation of the structure of the nucleus, such as the emission of γ-rays, emission of long range α-particles, fine structure of α-rays and their interrelations.

Rutherford as the Nucleus of a School of Distinguished Physicists

Rutherford had an almost unique and uncanny faculty of drawing the most original minds to him.

In 1921 a young Russian, Peter Kapitza was sent by the Soviet Government on a scientific tour; he came to visit Rutherford at Cambridge, who was so much impressed with the originality of the young Russian's ideas that he gave him facilities for carrying on original work in his laboratory. Here Kapitza developed his ideas for producing unheard of large magnetic fields (million gausses-white, formerly fifty thousand gausses was the limit) by the short-circuiting of batteries. Rutherford provided Kapitza with a fellowship, an independent laboratory and funds to enable Kapitza to give effect to his ideas. Under Kapitza's guidance was built up the Mond Laboratory for low-temperature research and magnetic investigations (the money was provided by Lord Melchett, the head of the famous Brunner-Mond Alkali Works). Here Kapitza worked till 1935 producing unheard of large magnetic fields and almost the absolute zero of temperature by a new helium liquefying apparatus and discovering many novel properties of bodies when placed at low temperature under large fields.

In 1927 there came another Russian, Gamow, who had found out a new way of approach towards the understanding of nuclear structure. In the scattering of α-particles by light elements, Rutherford had already noted facts of fundamental importance that when an α- particle approaches too close to the nucleus, the Coulombian law of repulsion breaks down and changes to one of attraction; and that the distance up to which the Coulombian law holds for uranium nucleus cannot be reconciled on classical ideas with the energy of the α-particles emitted from uranium. In 1928 Gamow, proceeding from Rutherford's work propounded that the nuclear particles are confined within a potential barrier out of which they can occassionally leak on account of their wave nature, thus giving rise to *spontaneous radio-activity*. This provided the first rational explanation of the phenomenon of Radioactivity on mechanical grounds and Rutherford quickly grasped the significance of Gamow's ideas and perceived that if nuclei were bombarded with high energy protons, deuterons, or other particles, they would be able to penetrate the nuclear potential barrier and bring about nuclear transmutation. From a study of the particles emitted from this artificial disintegration, much information regarding the structure of the nucleus can be obtained. As a sequel to this series of work Cockcroft and Walton in the Cavendish Laboratory first realized the transmutation of Lithium to Helium by artificially accelerated protons. This work was a prelude to a series of brilliant investigations on the transmutation of elements by artificially accelerated particles carried on in England, on the continent, and in America particularly by Prof. E. O. Lawrence of the University of California and his pupils with the aid of the cyclotron.

Discovery of the Neutron

In 1920, Rutherford in a Bakerian lecture had foretold the existence of the neutron—a particle having the same mass as the proton but without any charge. In 1930, Bothe and Geiger, two German physicists, had discovered that when polonium is placed in contact with beryllium, a new kind of radiation is given out which was much more penetrating than any γ-rays known at that time. I. Curie, daughter of the famous Madame Curie and her husband Joliot in Paris tried to find out the energy value of this supposed γ-ray from a study of their re-action with paraffin and also nitrogen. The two methods gave contradictory results. Chadwick (then Assistant Director of Research at Cavendish) who had in his mental background the idea of Rutherford's neutrons, found that the results could be explained if the Be—Po radiations were identified with Rutherford's neutrons. The hypothesis was put on a sure background by Wilson-chamber photographs of the new radiations by Feather and Dee. The discovery of this new universal particle which is in many ways more striking than the other fundamental particles owes much to Rutherford's far-sighted vision and inspiration.

Another outstanding achievement of the Cavendish Laboratory during Lord Rutherford's regime was the discovery of the positron by Blackett, a pupil of Rutherford, almost simultaneously but somewhat later than C. D. Anderson. Amongst other pupils of his who have made very notable

contributions to physics may be mentioned Ellis, Professor of Physics in the King's College, London, well known for his work on the β-ray spectra of radio-active elements, Appleton, discoverer of the layer in the ionosphere named after him, Cockcroft, Oliphant, Dee, and Feather already mentioned.

The above gives a very imperfect sketch of Rutherford's scientific achievements. The authors had not much time at their disposal to write a fuller and more comprehensive account.

Services to Science

Though Lord Rutherford was not a politician, he had done great things for the cause of science in England. English scientists of all ranks accepted his leadership and under his guidance have fought many battles with the bureaucracy for getting the claims of science recognized by the government. In fact, last year one of the most distinguished of British scientists, a Fellow of the Royal Society and a Nobel Laureate told the senior writer that whenever Rutherford found that the bureaucracy would not listen to the demands of science, he would tell his fellow scientists, "come on, let us go in for it and begin a frontal attack". His attacks were usually very telling. He was non-official chairman of the Board of Scientific and Industrial Research and was responsible for liberating this body from bureaucratic control and bringing it to the control of technocracy (scientists and technicians who understand the thing). We wish there were somebody in this country to do the same fighting with our Civil Service Bureaucracy. The claims of scientific men are being lost under the files of civil servants in this country. He was absolutely international in his outlook towards science. It is well known that it was mostly due to Lord Rutherford's initiative and influence that Jewish scientists deprived of their positions in Germany because of Nazi regime, were provided for in British and other universities. It led to the founding of the society for the protection of academic learning which has done, during the last couple of years, most useful work.

The Expansion of the Cavendish Laboratory

Under Lord Rutherford, the Cavendish Laboratory expanded greatly. His predecessor, Sir J. J. Thomson, narrates in his autobiography that during his regime (before the War), the official apathy to science was so great that in spite of growing needs, he could not get any funds for extension. He saved for a number of years £ 2,000 out of laboratory grants, added a wing, and to some extent relieved the congestion. But the situation has changed so much that Rutherford got last year even without asking, a cheque for a quarter million pounds for the extension of the laboratory from Sir H. Austin, manufacturer of automobiles. Lord Rutherford told the senior writer in 1936 that he was feeling for some time the necessity of extension and was thinking of issuing an appeal. He had invited Sir Arthur Eddington to pay a visit to the laboratory and write an appeal. Eddington did pay the visit and wrote the pamphlet, but it was never issued. In the mean-time, Rutherford happened to meet the Premier, Mr. Baldwin, who was the Rector of the University, and mentioned to him his plan of issuing an appeal. Two days later, he received the cheque. Mr. Baldwin had spoken to Austin, who came forward with the gift.

Prince of Experimenters

It is universally recognized that Rutherford was one of the greatest experimental geniuses the world has ever produced. In physical insight and intuition Rutherford belongs to that very small number of supreme investigators like Archimedes, Galileo and Faraday, who can easily separate the essentials from the details. What better examples can we have of his far-reaching physical insight than the way in which the capricious results originally appearing in his thorium experiments led him to the unravelling of the whole phenomenon of radio-activity, or minute deviations in the scattering of alpha-particles leading him to the nuclear theory of the atom, or the discovery of the neutron, or artificial transmutation. Physical science for ever will bear the stamp of his discoveries. To the outside world he will be known as the first man who

realized by his experiments the medieval alchemist's dream of the conversion of base metals into gold. He was one of the first to realize the truth of Einstein's great discovery of the equivalence of mass and energy upon which nuclear physics is built up. A day may come when the conversion of base metals into gold may be an actual possibility and from one gram of matter energy may be available which is now obtained by turning one ton of coal. These events when they come will have repercussions on the economic and political situation of the world of which we can have no proper perception at the present time. To take one example, when Faraday discovered the principle of electromagnetic induction in 1831, few people realized that this discovery would lead to revolutionary progress in communication, transport, and power production as we are witnessing today. Probably fifty years hence the full effects of Rutherford's discovery will be realized and after a hundred years mankind will reap the full fruits of his great discoveries.

Just at the time of writing this obituary, the authors have learnt that (Lord Rutherford was buried at the Westminster Abbey by the side of Newton and Faraday......It is a fitting Tribute to the Illustrious Dead by the great English Nation who will for ever feel proud of him, and his achievements in the field of Pure Science.

Lord Rutherford leaves behind him his wife, (Lady Rutherford) and his son-in-law Prof. R. H. Fowler, well-known theoretical physicist, and a number of grand-children. His only daughter, Prof. Fowler's wife, has been dead some years ago.

M. N. Saha.
D. S. Kothari.

Errata

In SCIENCE & CULTURE *3*,	p. 194. Col. 2, Line 17 *for* 'The cellulose in jute and similar etc.' *read* 'The cellulose in jute and ligno-cellulose and similar etc.'
" " "	p. 195. Col. 2, Line 8 *for* (in the long condition) *Read* (in the dry condition).
" " "	p. 197. Col. 2. Line 35 *for* 24·08% *read* 24·8%.
" " "	p. 197 Ref. 17 *for J. Indian Chem. Soc.* 1935, *12*, 17 *read J. Indian Chem : Soc.* 1935, *12*, 171 and 17.
" " "	p 197. Ref. 16. *for Indian Chem. Soc.* 1932, *9*, 291 *read J. Indian Chem. Soc.* 1932, *9*, 291.
" " "	p. 198. Col. 1. Line 3, *for* 'remained' *read* 'remains'

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Indian Science Congress Association, 1914-38

WHILE offering our felicitations and best wishes to the Indian Science Congress Association on the occasion of its Silver Jubilee Session it seems opportune to give a history of its development and take a stock of its service and achievements in the cause of science in India during the last 25 years. The 25th session of the Association will be unique in its history in view of the fact that the British Association for the Advancement of Science, which may be described as the parent body of all such scientific associations, has sent a very representative delegation of its members to take part in the Jubilee Session of the Indian Science Congress Association. The delegation was to be led by Lord Rutherford of Nelson who unfortunately died shortly before his departure for India. It will now be led by Sir James Jeans. A few wellknown scientific workers from other countries of the world are also attending this historic session. To all of them we offer a sincere and hearty welcome. We hope that this visit will not only enable them to gain a firsthand acquaintance with scientific work and workers in India, but also make it possible for them to judge how rapid has been the progress of scientific studies and research in this country during the past 25 years. May we also express a hope that the visit of these wellknown scientists will stimulate the progress of scientific research in the country.

The beginning of the Indian Science Congress, as it was called till 1935, was very modest indeed. Prof. P. S. McMohan and Prof. J. L. Simonsen, who had been appointed in 1910 to the newly created chairs of chemistry in the Canning College, Lucknow, and Presidency College, Madras, respectively, felt in view of the "great lack of scientific intercourse" in India that scientific research in the country "might be stimulated if an annual meeting of the workers somewhat on the lines of the British Association could be arranged." They were of the opinion that by such a meeting "*not only would the direct personal contact and association of actual workers be of great value, but also that the general public would be brought to realize the importance and value of scientific research.*" In the autumn of 1911 they, therefore, arranged to have an informal plebiscite by issuing a circular letter with a view to obtaining the views of other scientific workers in the country, in which they stated that the objects of the proposed association would be similar to those of the British Association for the Advancement of Science, *viz.*, "to give a stronger impulse and a more systematic direction to scientific enquiry, to promote the intercourse of societies and individuals interested in science in different parts of the country, to obtain a more general attention to the objects of pure and applied science, and the removal of any disadvantages of a public kind which may impede its progress." With this end in view the authors of the scheme proposed "to establish an association which shall hold an annual meeting (sectional or otherwise) in the more populous Indian towns where papers might

be read and discussed, the proceedings to be published in the form of an annual report." Realizing the importance of the co-operation of Indians for the success of the scheme they cordially invited "the participation of Indian scientists, convinced in the belief that in such measure as it is accorded the objects of the society shall more nearly approach fulfilment and its usefulness and permanence be assured." *En passant* it may be remarked that these words while reflecting the views of the European workers in 1910 have proved almost prophetic, for the peripatetic annual Science Congress has developed to its present proud position, not so much as a result of the efforts of its sponsors and the European scientists in India, but as a result of the unselfish labours and the hearty and sincere co-operation of almost all Indian scientists ever since the scheme was launched.

The replies received to the appeal referred to above made it clear that while the general consensus of opinion was favourable and even enthusiastic in favour of an annual meeting, some were doubtful of its success in view of the small amount of original research being carried out in India at the time, and it was further opined that the great distances in the vast continent of India might prove impracticable for such meetings. The sponsors, however, not daunted by these adverse opinions, selected in 1912 a committee of 17 "foremost men of science" in India to arrange for the holding of the first meeting. On Saturday, 2nd November, 1912, a conference, which was held in the rooms of the Asiatic Society of Bengal, Calcutta, with Dr. H. H. Hayden in the chair, resolved after careful consideration of various schemes "to ask the Asiatic Society to undertake the management of a Science Congress annually in Calcutta." As a result, a committee of the Society was appointed to work out a definite scheme for holding a Science Congress in January, 1914, simultaneously with the celebration of the Centenary of the Indian Museum, Calcutta. At a meeting of the special committee held on the 20th November, 1913, the committee was reconstituted and His Excellency Lord Carmichael, the then Governor of Bengal, was appointed as Patron, the late Sir Asutosh Mukhopadhyaya, the Vice-Chancellor of the Calcutta University, as the President, and Mr. D. Hooper as the Secretary and Treasurer, of the first Indian Science Congress* to be held on January 15, 16 and 17, 1914, in the rooms of the Asiatic Society of Bengal. A provisional programme was drawn up and widely circulated all over India about the same time. The first Science Congress was attended by 105 members from various parts of the Indian Empire, but this number was apparently materially increased by the large number of delegates who attended the Centenary of the Indian Museum. The first session of the Congress consisted of the sections of Chemistry, Physics, Zoology, Geology, Botany and Ethnography, in which in all 35† papers were read. The report of the first Science Congress, published as a part of the *Proceedings* of the Asiatic Society of Bengal, consists of about six pages of printed matter including the Presidential Address of Sir Asutosh Mukhopadhyaya and a list of papers read in the various sections.

After this session of the Congress at Calcutta at a meeting, apparently of its Committee, held on January 29, 1914, the following two resolutions were passed:—

1. That the Asiatic Society be requested to publish for the present an account of the proceedings of the Congress, and of such of the papers read as might be agreed upon by the Congress Committee and the Secretaries of the Society.

2. That the invitation to have that next meeting of Congress at Madras be accepted, the date and all other details to be settled by the Madras Committee in consultation with the Calcutta Committee and the Committee to be formed in other centres.

* Here it would be pertinent to mention that the name Indian Science Congress was adopted in view of there being already in existence in Calcutta an Indian Association for the Cultivation of Science with objects entirely different from those of the proposed Indian Association for the Advancement of Science.

† There seems to be a mistake about the exact number of papers communicated to the first session. The number given is based on the titles published in the *Proceedings* of the session, but Dr J. L. Simonsen in his presidential address to the fifteenth session of the Congress gave 31 as the number of papers read, while 32 are mentioned in the programme of the meeting.

From the above it is clear that at this stage no definite relationship had been decided upon between the Asiatic Society of Bengal and the Indian Science Congress beyond the fact that the first session of the Congress was held under the Society's aegis in the Society's rooms and that the proceedings of the Congress and such of the papers read at its each session as were agreed upon by the Congress Committee and the Secretaries of the Society were printed by the Society in its publications. On the financial side, the balance Rs. 370 out of the total amount of Rs. 883 raised mainly as subscriptions from members, after paying the expenses in connection with the Calcutta session, was remitted to the Honorary Secretary of the second session at Madras. No definite rules and regulations existed for the conduct of the Congress. There was no office or permanent secretarial body to carry on the work of the Congress when not in session or to ensure its continuity. The Committee in its meeting at Calcutta on the 2nd November 1912 had passed a resolution asking the Asiatic Society of Bengal to arrange for an annual meeting at Calcutta, and the Society did arrange the first session, but an annual meeting at Calcutta could not naturally have the support of other provinces, and, therefore, the original idea of the sponsors of the scheme to hold meetings at different places gained ground. The relationship of the Congress with the Asiatic Society, though not definitely expressed, was extremely close. It was, for example, expressed in the report of the Proceedings of the second Science Congress held at Madras in 1915, which, though printed at Madras, had the following legend:—

" Asiatic Society of Bengal
The Second
Indian Science Congress
Madras
1915 "

These proceedings were later reprinted with slight alterations in the *Proceedings* of the Asiatic Society of Bengal for the year 1915. From the beginning a very close relation had been established with the Society, and this became still more intimate since 1917 with the inclusion of its Secretary and Hony. Treasurer as *ex-officio* members of the Executive Committee of the Congress. Since that date the Society has acted as the Treasurer of the Congress, arranged for its publications and carried out most of secretarial work and ensured continuity when the Congress is not in session. In his Presidential Address to the fifteenth session of the Indian Science Congress, Dr. J. L. Simonsen remarked, " So far as I can see, the Society has not had any direct benefit from the connection, whilst to us it has been of incalculable value." This co-operation, which is clearly defined in the Rules adopted in 1935, has continued and we are definitely of the opinion that it has resulted in untold benefit to the cause of the Science Congress, and let us hope that the Royal Asiatic Society of Bengal, as it is now called, and the Indian Science Congress will continue to be associated in carrying on the good work in the cause of the progress of Science in the country.

The membership of the second session of the Indian Science Congress increased to about 150 and in addition to the 6 sections of the first Congress a section of Agriculture and Applied Science was also started. Some 60 papers were communicated to the different sections of this session.

It was decided to hold the third session of the Congress at Allahabad in January 1916, but later the venue was changed to Lucknow which had meanwhile assumed special importance as the capital of the United Provinces. We will not consider in detail the later sessions here, but it will be useful for a complete survey to mention only the places where the various sessions of the Congress have been held since this date. The first circuit was completed by the 4th-7th sessions being held from 1917-20 at Bangalore, Lahore, Bombay, and Nagpur. The sessions of the second circuit from 1921-27 were held at Calcutta, Madras, Lucknow, Bangalore, Benares, Bombay and Lahore. The third circuit sessions from 1928-34 were held at Calcutta, Madras, Allahabad, Nagpur, Bangalore, Patna and Bombay, while the first three sessions of the fourth circuit were held at Calcutta, Indore and Hyderabad from 1935-37, and the present Silver Jubilee session, the 4th session of the fourth circuit, is being held again in

Calcutta where the Congress had its birth, and which rightly holds the pioneer place in India not only because of its importance in commerce, trade, education, politics, etc.. but also as the centre of scientific activity throughout the country.

As Sir Alfred Gibbs Bourne, President of the Fourth Session of the Indian Science Congress at Bangalore, remarked in his presidential address, the Congress had managed fairly well up to that time without any rules, but one of the matters to be considered at that session of the Congress was the provision of some simple constitution, and apparently this was done at a general meeting before the close of the session when the future of the Indian Science Congress was discussed. According to these simple rules, the administration of the Congress was to be carried on by an Executive Committee which was, however, to submit such questions as they might consider desirable to the General Committee at its annual meeting. The latter was to consist of " all members who have attended three meetings (including that actually taking place at any time) and three members who have held office in the Congress." The Executive Committee, which was to advise on matters of general scientific importance and policy, was established by a resolution of the General Committee in 1922 and first constituted in 1923. In addition there was to be a Council consisting of the members of the Executive Committee, the past Presidents of the Congress, resident in India, and 5 other members appointed by the General Committee. The Sectional Committees were instituted in 1917; these referee all papers to be read before their respective Sections and in general are responsible for the work of the Sections. The original rules were added to or amended at the Eleventh session at Bangalore in 1924 and the Twelfth session at Benares in 1925. In 1931 a more detailed set of rules were adopted after considerable discussion, and finally the new set of rules which are now in force, and by which the Indian Science Congress Association was established were adopted at the Calcutta meeting on 5th of January 1935. The new rules are the result of the experience of working of the Indian Science Congress for almost 20 years and are fairly comprehensive for dealing with the work of the Congress.

Dr D. Hooper was the General Secretary for the first session of the Congress at Calcutta in 1914. From 1915 to 1921, *viz.*, the 2nd to the 8th sessions, the work of the General Secretaries was carried on by the sponsors of the original scheme, Prof. J. L. Simonsen and Prof. P. S. McMohan. Since that date several distinguished scientists, such as Sir Venkata Raman, Prof. S. P. Agharkar, Dr R. G. Norris, served as the General Secretaries of the Science Congress for varying periods. The present General Secretaries, Mr. W. D. West and Prof. J. N. Mukherjee, have carried out the traditions of the Congress to the fullest extent, and the success of the Jubilee Session would be due mainly to their indefatigable efforts. A reference may also be made here to the great service rendered to the cause of the Congress by Mr. Johan van Manen, the General Secretary of the Royal Asiatic Society of Bengal, in the earlier years as an *ex-officio* member of the Executive Committee and, during the last few years, in addition as its Managing Secretary.

Having dealt with the history of the Indian Science Congress we will now survey briefly the achievements of the Indian Science Congress in the cause of Science in India during the last 25 years. Prof. Simonsen and Prof. McMohan in sponsoring the idea of starting an institution like the Indian Science Congress were greatly influenced by the fact that, with the exception of the Asiatic Society of Bengal (now the Royal Asiatic Society of Bengal), there were at the time practically no scientific societies in India which afforded opportunities for scientific discussions either of the problems under investigation by various scholars or for exchange of ideas on subjects which were engaging their attention. In the earlier years undoubtedly the Indian Science Congress performed a very admirable function by providing a forum for the reading and discussion of papers in various sections. In the first session of the Congress at Calcutta there were 6 sections and, as noted above, 35 papers were read and discussed in the different sections. In the 23rd session the number of sections had increased to 10 and 570 papers were communicated to the different sections, while in

the last or the 24th session held in January 1937 at Hyderabad 729 papers were listed in the *Proceedings* for the different sections in addition to 6 general discussions which were also arranged either by the different sections themselves or in the combined meetings of the various sections. This state of affairs, though showing very clearly the great advances that have been made in the field of original scientific research in various branches of science in the country, does not reflect the exact progress made in the various fields. Further, such a large number of papers, as for example, 221 which were contributed to the chemistry section of the 24th session of the Congress, could not possibly be read or profitably discussed in a session which does not last for more than 4 actual working days. Under the circumstances, most of the papers cannot possibly be read, much less discussed, in the sectional meetings. We may compare this condition with the meetings of the British Association for the Advancement of Science. In the Report of the 104th Meeting held at Aberdeen in 1934, the number of papers, including discussions, in the Chemistry Section is only 21. When one considers the very great advances that have been made in the various sciences in England, one sees how the authorities responsible for conducting the proceedings of the British Association for the Advancement of Science have, with a view to getting the full value from discussions and interchange of thought as a result of such detailed discussions, found it necessary to reduce to the barest minimum the numbers of papers to be read in the various sections of any session of the British Association. Some very drastic treatment is now necessary if the Indian Science Congress also is to perform its real function of promoting scientific discussions rather than reading papers. This was well summed up by Prof. Simonsen in his presidential address at Calcutta when he remarked:

"Without desiring to minimize the importance of the reading of papers and the discussions arising therefrom to me the great value of our meetings has seemed to lie in the personal contact outside the lecture room. To our younger members it cannot but be an inspiration to meet and talk to the leaders of scientific thought in India. This aspect is, in my opinion, all too frequently lost sight of and I wish to take this opportunity of emphasizing it."

We are strongly of the opinion that now when there are a large number of specialist societies such as the Indian Chemical Society, the Indian Botanical Society, the Indian Physical Society, etc., and general scientific societies like the Royal Asiatic Society of Bengal, the National Institute of Sciences, the National Academy of Sciences, the Indian Academy of Sciences, etc., scattered all over the country for the reading and discussion of the results of researches in various sciences, the forum of the Indian Science Congress should be reserved more for discussion on subjects of greater and wider interest than that underlying the research problems which are being investigated by scholars all over the country. Not that we want in any way to minimize the value of such work, but we feel that it will give a greater impetus to scientific research of a high order if the meetings of the Science Congress could be devoted to such a function rather than to the reading of papers, many of which unfortunately are never printed. Looking through the reports of the British Association for the Advancement of Science we find that only a very small part, certainly not more than about one-fourth of the total report, is devoted to sectional transactions which correspond to the abstracts of papers read at the various sections of the Indian Science Congress; in the *Proceedings* of the latter they occupy certainly more than about 80-90% of the total volume. The remedy for such a state of affairs lies not with the Executive Committee, the President of the Congress, and the Presidents of the various sections, but with all those who consider the Indian Science Congress as an institution of vital importance for the progress of Science in India. We, therefore, strongly commend this for the consideration of the scientists all over the country and suggest that a general discussion of these problems should take place at the ensuing Jubilee Meeting and ways and means be devised for making it into a really useful institution rather than its usurping the functions of scientific societies, of which fortunately there are now a fair number represented all over the country.

Minor Planets

THE ancient people believed in the idea that there was something mystical about certain numbers. Of the numbers which received such distinction, seven is the best known. It is recorded that when in 1610, Galileo discovered the telescope, and observed with it the four satellites of Jupiter, one of his colleagues, Franceesco Sizzi, a Florentine astronomer, argued against the discovery as follows:—

"There are seven windows in the head, two nostrils, two eyes, two ears, and a mouth; so in the heavens, there are two favourable stars, two unpropitious, two luminaries, and Mercury alone undecided and indifferent. From which and many other similar phenomena of Nature, such as the seven metals, etc., which it were tedious to enumerate, we gather that the number of planets is necessarily seven.

"Moreover the satellites are invisible to the naked eye, and therefore can have no influence on the earth, and therefore would be useless, and therefore do not exist.

"Besides, the Jews and other ancient nations as well as modern Europeans have adopted the division of the week into seven days, and have named them from the seven planets; now if we increase the number of planets this whole system falls to the ground."[1]

Really speaking, the number of planets known before 1781 was six—Mercury, Venus, the Earth, Mars, Jupiter, and Saturn. Uranus was discovered by Herschel in 1781, and its discovery gave rise to a fresh chapter of activity in planetary investigation.

Bode's Law

The stimulus for this activity was provided by the widespread and almost universal belief that Nature abhors complicated laws. Students of astronomy know well how Kepler was guided in his epoch-making discoveries by the belief that the distances of the planets follow some simple geometrical law: after he had groped to his great discoveries, it was found that his earlier speculations about planetary distances did not agree with facts. But the heuristic value of the belief still remained, and the human mind even to this day, persists in the same track. In 1772, another astronomer Bode thought that the distances of the planets were approximately given by a very simple law.

This is obtained as follows: Let us first take the series of numbers

0	1	2	4	8	16	32	64	128	256

in which, it will be seen, each number after the first is double the preceding. Now multiply each by 3, so that we get

0	3	6	12	24	48	96	192	384	768

Add 4 to each of these, giving

4	7	10	16	28	52	100	196	388	772

These numbers are approximately proportional to the actual distances of the planets from the sun, which are (taking the Earth's distance to be 10):

Mercury	Venus	Earth	Mars	×	Jupiter	Saturn	Uranus	Neptune	Pluto
3·9	7·2	10	15·2	-	52	95·4	191·9	300·7	400

At the time Bode enunciated the law, Uranus and Neptune were not known. After the discovery by Sir William Herschel of Uranus in 1781 it was found that its distance from the sun was close to the value predicted by Bode's Law, and this confirmed the belief that there might be some truth underlying the Law.

There is a gap, it will be seen, in the Law, between Mars and Jupiter at the place marked 28 at which number no planet exists. It was noted

1. Sir Oliver Lodge, *Pioneer of Science*.

by Kepler, and a mediéval astronomer Titius predicted the existence of a planet between Mars and Jupiter. After the discovery of Uranus the idea became stronger that originally a planet probably existed in this position (28), which was broken up by some unknown catastrophe into a number of smaller planets, each being very small and invisible to the naked eye.

Discovery of Ceres

This speculation set a number of astronomers to the exciting game of hunting for new planets. A society composed of 24 astronomers was formed with Baron von Zach at their head, to look for the missing planets. The first success was achieved by the Italian astronomer, Piazzi, who on the New Year's day of the year 1801 found a star of the 7th magnitude through his telescope at a place where previously he had not observed any. A closer examination revealed that the star had a motion like that of any other planet. It is well-known that the so called fixed stars have very little motion so that their relative positions in the sky remain almost invariable. The planets, however, move in the field of the stars. So an examination of a suspected new body at an interval of a few hours suffices to show whether it is a star or a planet.

It is well known that the so-called fixed stars have very little motion so that their relative positions in the sky remain almost invariable. The planets, however, move in the field of the stars.

The new-comer was proved to be actually a planet and its distance was found to be 2.8 times that of the Earth from the Sun, as predicted by Bode. But the planet was extremely small (only 800 km. in diameter, and possessing 1/2000th mass of the earth as later observations showed). In honour of the patron deity of his native island of Sicily, Piazzi called it "Ceres". It was only a seventh-magnitude star and invisible to the naked eye. After the discovery of this planet it was believed that there were probably others still to be discovered. But "Ceres" was lost to view before sufficient observations had been taken of its position and any computation could be made of its orbit. This was a sad misfortune, but situations like this sometimes call forth an unexpected genius. On this occasion, the difficulty was solved by the appearance of a new star in the mathematical horizon. This was Frederich Gauss, then a young rising German mathematician at Göttingen, who was earning his livelihood by giving private lessons in Mathematics. The loss of Ceres, called forth his mathematical resources and he worked out a new mathematical method of calculating the orbits of planets from three close positions quite accurately. It was a most powerful method and has been a very helpful guide in finding the orbits of other minor planets. Guided by the calculations of Gauss, Olbers of Breslau, one of the 24 "Celestial Policemen" appointed by von Zach was able to rediscover *Ceres*.

A number of other small planets or asteroids were discovered in quick succession but they all proved to be extremely small. Pallas was discovered by Olbers in 1802. Juno was found by Hardinge in 1807, and Olbers discovered Vesta which is the only asteroid just visible to the naked eye. Then after a long period in 1845, after the astronomers had practically given up the hunt the 5th asteroid was discovered by Hencke, an amateur, and was called Astraea. The discovery of Astraea revived interest in the belief that there were more such small bodies in existence which could not be discovered on account of their extremely small size. In fact, the method was like hunting for grains of gold in a sandy river-bed. But by patient and persistent work, astronomers were able to discover 300 small planets or asteroids by 1890.

A New Method of Planetoid Hunting

In 1891, a very powerful method for finding out the asteroids was discovered by Max Wolf of Konigstül Observatory near the famous Heidelberg City in Germany. He set up a camera consisting of a wide angle lens, mounted equitorially and moved by clock work against a field of stars; the camera was rotated at the same rate as the celestial globe. In the focal plane of the camera, the stars would therefore appear as mere dots, as they have no proper motion. But the little planets if any, in the area selected would be represented by

elongated lines. An examination of the plate would easily reveal whether any asteroid was situated in the field of view of the camera at the time of exposure. This new method at once replaced the older method of painfully hunting the whole heavens through a telescope in search of asteroids. All that is needed is to set up the camera to do this reconnoitring work and any asteroid which comes within the field of view, provided it is sufficiently large, cannot fail to respond to the roll-call. The powerfulness of this new method will be apparent from the fact that since 1891, from 100 to 200 asteroids are being discovered annually, by this method. The following is a census of the detections since 1931.

1931	1932	1933	1934	1935	1936
162	200	188	269	252	262

This method has the disadvantage that very small planetoids fail to make any impression on the camera, as their light is spread out. So another modification of the method has been worked out: in this, the camera is given a motion equal and opposite to the average motion of the asteroids. So on the plate, the asteroids are reduced to rest, while the stars describe small curves. As the light of the asteroids is concentrated at one point for a long time, even very small ones are recorded by this method.

A number of observatories have made planetoid-hunting their chief activity, *e.g.*, Observatory of Max Wolf at Konigstühl in Heidelberg, Simeis in Russia, Ucele near Brussels in Belgium.

How Planetoids are Christened

Up to this time more than 3000 observations of the asteroids have been made. But all of them are not discoveries. Some of them are re-discoveries of planetoids already detected. The work has been systematized by the International Astronomical Union. The Rechen Institute of Berlin has been entrusted with the task of finding out whether an announced detection actually represents a new object or is simply a re-detection of one already discovered. When they are convinced that it is a new discovery, a number is given to the new object. Up to this time, about 2000 numbers have been given. Thus Ceres is (1), Astraea is (5) and so on.

The naming of the planetoids presents a great difficulty. Formerly they used to be named after the old gods and goddesses of Greece and Rome. These names were soon exhausted. Then they were named after distinguished astronomers, cities, colleges, friends and even after pet dogs and ocean steamers. But it is better to call them by the number given to them by the Rechen Institute which publishes annual catalogues of these planetoids and tries to collect at one place all their characteristics, namely mass, distance, orbit and reflecting power.

A study of these asteroids has shown certain very remarkable facts. Their mean distance is found to be 2.8 as predicted by Bode. But individual asteroids have been found, which are much farther and others which are very near. (944) Hidalgo discovered by Baade in 1920 has been found to have a mean distance of 5.7 and a period of 13.7 years. Its orbit is inclined at 40 degrees to the ecliptic, and has an eccentricity equal to .65. When it is nearest to the sun, the distance is nearly two units, and when it is farthest it passes beyond the orbit of Saturn.

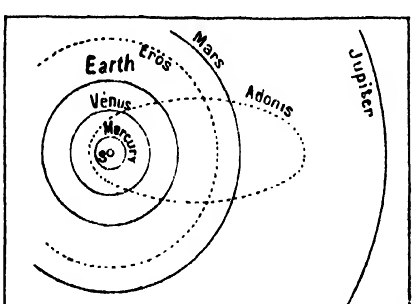
Eros

The asteroid which caused the greatest amount of interest is (433) called Eros, discovered in 1898 by Dr. Witt of Berlin. Eros has been found to have the remarkably short period of 1¾ years. As a matter of fact, its orbit is for the most part between that of the Earth and Mars, and at its nearest approach to the Earth, it is at a little more than half the distance of Venus which is our nearest planet. This little planet which is probably not more than 25 miles in diameter therefore affords the best opportunity of finding out the scale of astronomical distances. All familiar with astronomy know that for expressing the distances of planetary bodies, the mean distances of the Earth to the Sun is used as the unit. The gravitational theories enable us to find out the distances of other bodies only in terms of this primary standard. To find out the actual distance in centimetres we have to find out the value of

this fundamental astronomical unit in centimetres. It will suffice for this purpose, however, to know the actual distance of any of these heavenly bodies in centimetres. Prior to the discovery of Eros, Venus was used for this purpose on those rare moments when it passed across the disc of the Sun (Transit of Venus). But these transits are few and far between. Eros is much closer, and transits more frequently across the disc of the Sun. It has therefore supplanted Venus for this purpose. But even Eros will probably be supplanted by a new acquisition made last year (1936).

Adonis

This remarkable, small planet was discovered on the 12th February 1936, by Mr. Delporte, Director of the Royal Belgian Observatory at Uccle near Brussels. Adonis has been found to move in a very elongated ellipse. When nearest the Sun, it is well near the orbit of Mercury and when it is farthest from the Earth it is betwen Mars and Jupiter. In fact, it was found to have passed within 1.2 million kilometres of the Earth a few days before its discovery. Its orbit is inclined at one degree to the ecliptic, so that there is a probability that in course of its motion near the earth, it may approach very close to the latter. As a matter of fact, calculations have shown that in 1955, Adonis will pass very close to the Earth. What will happen to the earth then? There are three possibilities:—



The Orbit of the Planets

(1) Most probably Adonis will have such a large velocity that it will be only slightly disturbed by the attraction of the earth and will pass on its orbit.

(2) The second probability is that it will be captured by the earth and will form a tiny moon, tiny because though called a planetoid it is only a big meteorite, having a diameter of about half a kilometer.

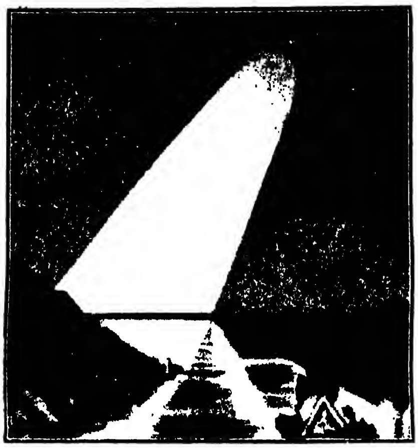
(3) But the third possibility which the astronomer H. N. Russell calculates to be one in 50,000 is the most staggering. It might be that Adonis may have very insufficient velocity when approaching close to the earth. It will then be subjected to so much attraction that like a huge meteor, it will flash across the atmosphere and strike the surface of the earth with a velocity of 30 kilometres per second.

While one can shudder at the consequences of such a catastrophe; the only parallel case known is that of a great meteor which fell in Siberia in 1908. It weighed only 100 tons, but the atmospheric disturbances and seismic influences produced by it were registered all over the world. Adonis, on the other hand, has a weight of 2 billion tons, so that the consequences of a collision, if it ever happens, can better be imagined than described.

The Origin of the Asteroids

The discovery of Adonis has given rise to fresh speculations about the origin of these interesting bodies. The original idea which set astronomers to this task was that there was a planet between Mars and Jupiter which was broken up by some impact into millions of pieces. This idea has been given up for a long time. The present theory is that smaller asteroids form a kind of ring round the Sun very much like the rings of Saturn, which have been shown to consist of small pebbles each moving in its orbit round the parent planet. The sizes of these pebbles vary from few centimeters to mere dust. Probably the inhabitants of Saturn, if there be any as such beings, would find the Sun surrounded by a similar set of rings, but it is doubtful whether, unless they possess big telescopes like ourselves they would be conscious of the existence of the rings we get a very dim view of this ring in the so-called Zodiacal Light, which is a familiar feature in the sub-tropical regions on any clear moonless night, and, no place is better suited for its observation than Upper Egypt which

has got a perfectly clear atmosphere. Here after the setting of the sun, one can discern within the heavens a luminous fog extending along the ecliptic and having an intensity which is comparable to that of the Milky Way. It generally extends up to 90 degrees to the Sun. Sometimes it extends through the whole heavens along the path of the ecliptic, and on the point opposite the Sun there is a concentration of light which is known as the *Gegenschein*, a German word, meaning *Antilight*. The origin of this light has puzzled the astronomers for a long time. From a study of its spectra it has been found that the *Zodiacal Light* is simply reflected sunlight, because the spectrum consists of a continuous background intersected by dark Fraunhofer lines. But it does not at all tell us whether reflection is due to gases or to dust particles. If the cloud is gaseous, the reflected light will be perfectly polarised like the sky light. If it is formed by solid dust no trace of polarisation will appear. Observations show that the Zodiacal Light is slightly polarised. The conclusion is that the ring is constituted by solid particles which on approaching the orbit of Mercury and the Earth get partly vaporised. It is surmised that this ring of pebbles, dust and vapour constitutes Zodiacal Light which extends as far back as the orbits of Mars and Jupiter and what we call the asteroids are only the larger numbers of these rings. As a matter of fact, a number of small planetoids, similar to Adonis, though not so striking, have already been found. One such planetoid was discovered by Reinmuth in 1932, and is now called Apollo. This is about 1·5 km. in diameter, has a period of 1·8 years, and the greatest distance is 2·32, but while at perihelion, its orbit is 12 million kelometers inside the orbit of Venus.



Zodiacal Light.

There are Vacuums, and Vacuums

Beyond the extremes of the earth's atmosphere is an almost perfect vacuum. In between the stars, which occupy only about one billion-billion-billionth part of space, we find a few meteors, some cosmic dust, and a small number of atoms. The investigation and analysis of this rarefied inter-stellar gas is obviously not a simple matter. Imagine, if you can, a tube one foot in diameter and 50 million million miles in length. Such a to Sirius, a distance of about nine light-years. Ac Sirius, a distance of about nine light-years. According to actual measurement, the density of interstellar gas is so low that in this entire great tube would be found only one-tenth of a gram of substance, just about the equivalent of the air in your ink bottle (the density is about one hundred million times smaller than that of the best vacuum producible on earth).—*The Telescope.*

Sir James Hopwood Jeans

President-Elect of the Silver Jubilee Session of the Indian Science Congress, Calcutta-1938

A. C. Banerjee

Head of the Department of Mathematics, Allahabad University.

Sir James Hopwood Jeans who has now accepted the invitation of the Indian Science Congress Association to preside over the joint session of the Indian Science Congress and the British Association for Advancement of Science to be held in January next, at Calcutta, was born in 1877. He was educated at the Trinity College, Cambridge, became second wrangler in 1898, and

Sir James Hopwood Jeans

was awarded the Smith's Prize in 1900. His first publication was a work of great importance on the Dynamical theory of Gases. His primary aim was to develop this subject upon as exact a mathematical basis as possible. He has been very successful in his attempt and is now regarded as one of the foremost authorities on this subject.

Researches on Planetary and Stellar Figures

Jeans was awarded the Isaac Newton Scholarship in the University of Cambridge and became a pupil of Sir George Darwin son of the great naturalist, and himself a great mathematician who made an extensive study of tides and of planetary figures. It was natural that he should become fascinated by the problem of steller evolution which was engaging the attention of the astronomers in the beginning of the twentieth century. The problem at this time started with an examination of the various forms of equilibrium assumed by a mass of revolving liquid and it became a burning question of the day as to whether the pear-shaped form is a possible stage in the development of a star on its way to separation into a binary system. In 1901 Sir George Darwin and the great French mathematician, Hénri Poincaré, wrote two highly interesting papers on the pear-shaped figure of equilibrium of rotating liquid masses. But they either overlooked the fact that the actual bodies we have to deal with in connection with stellar evolution are compressible and most probably gaseous, or chose incompressible liquids as the stuff out of which stars are made for the sake of mathematical simplicity. But actual physical conditions do not follow the mathematician's convenience. Jeans' special knowledge of the theory of gases enabled him to call attention to the fact that compressibility and gaseous character of the bodies lead to some very different conditions which were not at all considered by Darwin and Poincaré in the more restricted problem in which fluid was assumed to be incompressible. We shall discuss Jeans' work on rotating compressible fluid later on.

Jeans' paper on the stability of a spherical

Nebula was quite noteworthy as it was the first to introduce the conception of gravitational instability. He shewed that nuclei of condensations are likely to form in an extended nebula, and these grow in size by attracting matter to themselves, and so the original nebula becomes separated into distinct parts. We thus get another cause of separation of primitive nebulae besides its possible fission through too rapid rotation, as was originally postulated by Kant and Laplace.

As the mathematical analysis of three dimensional problem was found to be too difficult, Jeans tackled at first the simpler two-dimensional problem of a rotating cylindrical mass of liquid. He found that for slow rotation the cylinder was circular, and for more rapid spin it became elliptical. When the spin still further increases, we get the two-dimensional analogue of the pear shaped form. Later on, Jeans tackled the much more difficult three-dimensional problem, and in 1917 he reached the fruition of his efforts, when he was awarded the much coveted Adam's Prize on a remarkable essay on the "Problem of Cosmogony and Stellar Dynamics." In this essay, he discussed mathematically the cosmological problem as to how detached bodies like the stars, the planets, and the satellites have been formed out of matter which is supposed to have filled space more or less continuously in the beginning.

Darwin believed that he had proved the initial stability of the pear-shaped form of equilibrium. Jeans, on the other hand, demonstrated beyond doubt its instability and also indicated precise point at which Darwin was misled to form the wrong conclusion. The star cannot maintain the pear-shaped form for any length of time, and when the spin becomes too great break-up will follow resulting in cataclysm. Jeans studied in detail, for both the rotational and the tidal problems, the dynamical conditions which would lead to the break-up. He also considered fully the modification caused by the compressibility of matter and demonstrated a new possibility that the mass may spread out and separate through "equatorial break-up." For sufficient spin and compressibility the equator of the figure becomes sharply protuberant and the form is like that of a lens. If spin still increases matter is thrown out in a continuous stream from the equator. Nuclei of condensation may, later on, form in the spread-out stream which may ultimately break up into separate parts.

It is highly interesting to note the different behaviours of incompressible liquid and highly compressible matter under excessive spin. The former breaks up by elongating itself (fission) so that the liquid becomes furrowed and ultimately divides into two parts; the latter on the other hand never reaches sufficient elongation but throws out matter all round the equator and the impending catastrophe is thus delayed or avoided. According to Jeans, a close binary star is formed out of the original star by the first kind of separation (fission). But a giant star in the state of a perfect gas cannot split into two components this way. According to Jeans a close or a spectroscopic binary is in the later stages of evolution where a comparatively high density has been reached, and its behaviour is analogous to that of the incompressible liquid under excessive spin.

We have so far discussed Jeans' ideas about the mode of formation of a close double star.

Jeans gives a different theory about the formation of wide or visual binaries. He believes that they were born together as separate condensations in some parent nebula. From the study of equilibrium of bodies consisting of compressible gases Jeans was led to suggest that equatorial rupture is mainly responsible for the formation of spiral nebulae. If there be no disturbing force matter would be emitted symmetrically round the equator. But even a small disturbance, say, the tide-raising force of a distant mass would mar the symmetry and two arms of matter on opposite sides, would stream out and these arms would get curved due to rotation like a gigantic Catherine wheel. Jeans has shown mathematically that these jets are unstable and ultimately condensations which are the nuclei of the stars would be formed along the arms. The geometry of the spiral arms raises great difficulties. The arms of about ninety per cent of the spiral nebulae have the characteristic shape of an equiangular spiral There does not appear to be any along the arms as the length of the arms remain permanently equal to two convolutions. Again secondary

nebulae are observed at the ends of the arms of a number of spiral nebulae. It is almost impossible to explain the geometrical shape of the spiral nebulae by assuming that it is due to pure rotation caused by known forces. Jeans admits this difficulty and says "Each failure to explain the spiral arms makes it more and more difficult to resist a suspicion that the spiral nebulae are the seats of the types of forces entirely unknown to us—forces which may possibly express novel unexpected metric properties of space." It may be said in passing that probably at the time when these investigations were being carried out, the astronomers had no adequate idea of the relative sizes of extragalactic nebulae, compared to that of a planetary nebula, or of an ordinary star. It is only after 1920 that the researches of Shapely, Curtiss, Lundmark, Hubble, and others have revealed that the extragalactic or spiral nebulae are huge agglomerations of stars, consisting of billions (10^{12}) of usual stars, like our Milky Way (which is itself a nebula). While the older investigations (including those of Jeans) may hold for individual stars (including Planetary Nebula which is only a particular kind of star), the problem of spiral nebulae has to be attacked from an entirely new setting.

There is no doubt that rotation plays an important part in the evolution of a star system, but a very relevant question may be asked, which has not yet been satisfactorily answered. What is the source of this high speed of rotation? Jeans has tried to explain this by assuming that initially some disturbance started somehow and it produced condensations. As masses contracted round the nuclei of condensations, drifts were produced, and eccentric drifts gave momentum to these nuclei which thus formed into rotating nebulae. If the original currents were less than 'a kilometer per second' Jeans has calculated that the angular momentum which would be generated is sufficient to produce that rotation which we observe in "Andromeda Nebula." However this explanation is not quite satisfactory.

Origin of the Solar System

Our readers must be familiar with the story of Nebular Hypothesis of Kant and Laplace. Generations of astronomers have tried to find out mathematical support for the hypothesis and Jeans' efforts were, as the readers can see, directed along the same channel. As to the Solar System, Jean's mathematical work had led him to conclude "It is quite probable, though by no means certain, that we must abandon the nebular hypothesis." Perhaps Jeans was wise in not having spoken more dogmatically.

About the origin of the solar system, Jeans believed that about 2300 million years ago, a larger star passed within a distance of about the sun's diameter from the surface. A system of matter ejected out and it being unstable condensed into detached nuclei which ultimately formed planets. The passing star communicated orbital velocities to the planets and they began to describe elliptical orbits round the sun, passing fairly near to the sun's surface at their closest approach. The chain of the jet would be of cigar-shaped form, and the end of the chain would get colder than centre through greater radiation. So the more massive gaseous planets would be at the centre of the chain and the more liquid planets which are lighter would be at the end of the chain. As the planets passed relatively near the sun, the same tide-raising process resulted in the formation of satellites out of planets.

An objection may now be raised against this tidal-action theory of Chamberlain as modified by Jeans; as statistically it is highly improbable that two stars would come so near as to raise tides in each other. The chances of such a cataclysm is extremely small and if tidal action be responsible for birth of our planets, then our planetary system will be a freak of Nature and perhaps amongst billions of stars, two or three may be endowed with planetary systems. Are planetary systems so rare in the universe? This conclusion is not satisfactory and does not appear to be logically sound. It is perhaps true that the planetary evolution is not the natural process associated with a star. Binary stars are scattered abundantly in space, and we can say that something like half the stars are binary suns, and it is unlikely they have got any planetary systems. Such a system would produce great complications in the relative orbits of the components of a binary star. The remaining half of the number of stars

might well have been provided with planets, but prodigal Nature is not so just and considerate in her dealings. She has probably endowed very few stars with planetary systems. However our solar system is the only specimen of its kind known to us at present, but this does not mean that our system is unique in the universe.

Researches on Radiative Equilibrium

Jeans also has made numerous contributions to astrophysics. His researches on the radiative equilibrium of stars led to vigorous controversy between him and Eddington. Eddington derived an equation which he believed to be true for all stellar matter including the case in which the stellar matter is continually generating energy. Jeans disputed Eddington's formula and maintained that it is only accurate in stellar matter in which there is no internal generation of energy, and when there is internal generation of energy the formula should be suitably modified.

Jeans has given an interesting theory to explain the periodic variation in the intensity of light emitted by that group of stars known as Cepheid variables. Jeans had shown before that "fission of a rotating star commences through pseudo-ellipsoidal configuration and that it can only begin in stars whose central cores are in liquid or semiliquid forms." The pseudo ellipsoidal form which the star assumes when the process of fission begins is unstable. As a result of secular instability the core of the star will now undergo oscillations which produce periodic variation in the intensity of light emitted by the star. According to Jeans, Cepheid variables are those stars which are undergoing at present the process of fission. Finally when the star breaks up into two it will form a binary pair. It may be pointed out here that in 1919 Eddington put forward the theory that Cepheid variables are pulsating spheres, but Jeans proved beyond doubt that the pulsation theory was untenable, and the validity of Jeans' argument was later on conceded by Eddington.

Jeans was one of the first to talk of annihilation of matter by the impact of postive and negative charges, and conversion of matter which disappears thereby to radiation. He talked also of the reconversion of the radiation to matter, as otherwise the cosmos would suffer a 'Heat-death (Wärme-Tod). But physics has very often showed a disinclination to obey the mathematicians' predictions, and the annihilation of matter and reconversion of radiation to matter (production of pairs), though subsequently actually discovered in the laboratory, are widely different from what the astrophysicists predicted.

Stellar Dynamics

Jeans has also made valuable contributions to stellar dynamics. Stellar dynamics deals with the individual motion of the stars as modified by the attractive forces of other stars or rather by the resultant attraction of the stellar system as a whole. One of the most important points to consider is whether under these forces the system would be in steady state, i.e., whether the density of stars and their orbital velocities would remain constant at each spot. A steady state is a permanent state. Jeans does not affirm that our actual universe is a permanent system, but he thought that it would prove simpler if steady systems were treated before collapsing systems.

Before attacking this problem in stellar dynamics, Jeans first showed mathematically that if a dynamic system is in a steady state, the frequency-function must be a function of the first integrals of motion. If we imagine that in the vast expanse of space, individual stars are situated at so many points, then the frequency-function gives the number of stars at each point $(X, Y, Z,)$ moving with velocity $(U, V, W,)$ for all values of X, Y, Z, U, V, W. In general we come across only one first integral of motion, *i.e.*, the sum of kinetic and potential energies. Jeans further showed that for a steady state, the possible range of frequency functions is extremely limited, and these functions must depend only on the first integral of motion. But if the system has some symmetry we get additional integrals which offer greater possibilities. Jeans studied these possibilities exhaustively.

Jeans made some striking deductions from his theorem which gives the conditions for a steady state. If the stars are distributed in such a way

as to have no axis of symmetry, there cannot be any preferential direction of motion and the velocities of the stars will be so distributed as to have complete *spherical* symmetry; on the other hand, if the stars are so distributed as to have an axis of symmetry the velocities of stars will be so distributed as to have an axis of symmetry in the *transverse* direction. If the stellar system is symmetrical about the axis perpendicular to the galactic plane, there would be star streaming in the galactic plane in transverse direction and not in the radial direction. It is rather curious that we have the complimentary law:—the more symmetry there is of mass distribution, the less is needed of velocity distribution and vice-versa. It is still an unsettled question as to whether the star streaming is radial or transverse in character. Some think that the star streaming is in line towards and away from the galactic system while others maintain that it is transverse *i.e.*, in the direction of a circular motion about the centre. Eddington thinks that transverse star streaming is not possible and concludes from Jeans' result that our galactic system is not at all in a steady state.*

Jeans has also calculated the average deviation in a star's motion which would be produced by the chance approaches of other bodies. He has thus been able to explain the flattened shape of some of the moving clusters of the type, Ursa Major Cluster. He has shown that this flattening is due to gradual scattering by chance encounters.

Jeans' Contribution to Physics

Though Jeans has been primarily an astronomer he has occasionally strayed into physics, and with admirable results. In the dynamical theory of gases, his contributions placed the Maxwell-Boltzmann Law of distribution of velocities on a rigid mathematical basis. He took part in the discussion which was raging in the early part of the present century on the form of the black body emission curve. He showed with considerable mathematical ingenuity that classical electrodynamics can lead to no other law than the one previously given by Lord Rayleigh,—which has therefore acquired the appellation of Rayleigh-Jeans Law. It became known that this holds only for long waves, and for short waves, the measurements of Paschen showed that the law completely failed. It was at this stage that Planck appeared on the scene (1900), and by boldly laying aside classical electrodynamics, deducted the true law of black body emission and laid the foundations of the quantum theory.

Public Career

Jeans was, like many other British scientists of eminence, called to the chair of Applied Mathematics in the Princeton University, where he worked from 1905-1909. He was Secretary of the Royal Society for ten years from 1919-1929.

Jeans was President of the Royal Astronomical Society from 1925-1927. In 1934, owing to the untimely death of President Elect, Sir William Hardy, he was called upon to act as President of the British Association for Advancement of Science. His address 'On the New World Picture of Modern Physics' was not only marked by his usual lucidity of exposition, but presented the bewildering adventures of modern physical ideas about the ultimate particles in a way which even the man in the street could comprehend. From 1935, he has been the Professor of Astronomy to the Royal Institution.

Jeans has been the author of an unusually large number of Text Books, Popular Scientific Books and Special Treatises. Many of these books have gone through numerous editions which testify to their popularity and usefulness.

We look forward to a successful session of the Indian Science Congress during its Silver Jubilee under the distinguished lead of Sir James Hopwood Jeans.

* The whole outlook in galactic dynamics has since been changed due to the discovery by Lindblad and Oort, that our galaxy is rotating about a point in Sagittarius clouds, with a period of revolution of 10^8 years.

Red Shift in the Solar Spectrum

R. N. Rai

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A small but systematic difference between the values of the wavelengths of the lines in the Fraunhofer spectrum and those of the same lines produced in the laboratory has been observed since 1895 when Jewell noticed it while measuring spectra for Prof. Rowland's "New Table of Standard Wave Lengths". All solar lines are displaced towards the red, although the difference is different for lines of different intensity of the same element and also depends upon the depth of the point of observation and its distance from the centre of the Sun, being greater for the limb and less for the centre.

We also observe, in the spectra of the distant nebulae, a shift towards the red of the *H* and *K* lines of ionized calcium. This shift, which amounts to several hundred Ångstroms, has been ascribed to a velocity of recession, in the line of sight, of the distant nebulae. This explanation cannot be put forward to explain the red shift of the solar lines, since the light received from the opposite face of the sun, by reflection from Venus, does not show the opposite effect. A very high pressure, amounting to 2 to 7 atmospheres, was at one time assumed to exist in the chromosphere to explain this shift, but it has now been definitely established that the pressure in the chromosphere is very low.

We should however expect a small red shift on the theory of the general relativity as predicted by Einstein. Measurements, carried out by Dr St. John at the Mount Wilson Observatory, for 1537 lines at the centre of the sun seemed to confirm Einstein's prediction although the shift for 133 lines taken at the limb showed an excess over the Einsteinian prediction. This excess, it has now been shown by Evershed and Royds, actually amounts to the predicted shift itself, *i.e.*, the total shift is double of the Einstein shift. This result is against the general theory of relativity which predicts a constant shift irrespective of the intensity of the lines and the point of their origin in the solar disc. It is, however, in accord with the prediction of Sir S. M. Sulaiman's theory, according to which the shift should increase from the centre towards the limb, being at the limb twice its amount at the centre. Writing in this connection Evershed observes in the *Observatory*, Oct. 1937:—

"In the *Proceedings of the National Academy of Sciences of India* (Vol. 1936) and in the *Indian Physico-Mathematical Journal* (Vol. 8-1937.), Sir S. M. Sulaiman has propounded a new theory of light, according to which a light corpuscle consists of a binary system with components of equal mass and opposite charges, rotating round each other and travelling with the velocity of light. One consequence of this theory is that the spectral shift at the edge of the Sun should be twice the Einstein value. Another makes the deflection of light of stars that passed the Sun to be between 1·3 and 1·5 times the Einstein value. *These predictions might be thought to be confirmed by my measures of the iron lines in the red,* and by Freundlich's observed value of the deflection of the stars near the edge of the Sun. But it does not seem probable that all the lines of iron are subject to a shift which is twice the Einstein value, and we have to consider also the lines of other elements than iron. I have found from the recent measures of the sodium D lines that the displacement at the limb of the Sun and at the centre, and presumably over the entire disc, has precisely the Einstein value of +0·0 145A. These lines represent a high level in the reversing layer, and are therefore not subject to the outward movement of the lower gases, but there is no excess at the limb."

Some time ago, Sir C. V. Raman, reviewing "Solar Sclipses" by Sir Frank Dyson, and

R. V. D. R. Woolley in the *Current Science*, a scientific paper from Bangalore, wrote

"From this account it appears that Einstein's prediction from his general relativity is verified by the observations. This chapter should be of special interest to those readers in India who may have been inclined to give credence to the numerous reports and publications emanating from Allahabad regarding the alleged demolition of Einstein's theory of Relativity (*Current Science*, Sept. 1937)."

We recommend the above extracts from Evershed to Sir C. V. Raman for perusal. He will find that he has still to learn a good lot about Allahabad. The fling was entirely uncalled for as the book under review was published early in 1937, and was probably written in 1936, and the writers were at the time unacquainted with the results of the Eclipse Expedition of 1936, or the careful measurements of Dr Evershed.

C. Davisson and G. P. Thomson

The Nobel Prize in physics this year has been awarded to Dr. Clinton Davisson of the Bell Laboratories, New York, and Prof. George Paget Thomson of the Imperial College of Science, London. The awards have undoubtedly been made in recognition of their experimental work on electron diffraction carried out in 1927. These experiments afforded the first direct confirmation of de Broglie's' theory attributing wave properties to electrons, which won for him the Nobel Prize in 1929. Not only have their experiments supplied by far the most direct evidence for the principles underlying wavemechanics, on which today the whole of atomic physics is based, but their applications have provided very useful methods for the study of surface films, of molecular structure, and of crystal growth.

Wave Nature of Electrons

In an attempt to reconcile the older ideas of the wave-theory with the more recently discovered facts demonstrating that radiant energy travels in the form of localized quanta of energy or photons, L. de Broglie, in 1924, first conceived the idea of attributing wave properties to electrons and other moving particles. His hypothesis required that the wavelength to be associated with electrons would be given by $\lambda = \frac{h}{mv}$, where m is the mass and v the velocity of the electrons. For cathode-ray corpuscles of, say, 25,000 volts energy, the wavelength calculated from the above relation comes out to be of the same order as that of hard X-rays, so that these corpuscles should show similar diffraction effects. This was first demonstrated by successful experiments in 1927 by C. Davisson and a little later by G. P. Thomson.

Davisson and his Experiments

Born in 1881, in Illinois, U.S.A., C. Davisson obtained his doctorate from Princeton University and was for some time a lecturer in physics in the Carnegie Institute at Pittsburgh. For the last twenty years he has been working in the Bell Laboratories in New York. Like many other great discoveries in science, Davisson's experimental verification of the wave nature of electrons was the result of an accident. As early as 1921, Davisson and his collaborators were carrying on a series of investigations on the angular distribution of electrons scattered by a target of ordinary platinum. Similar experiments were being carried on later (1925) using a target of ordinary polycrystalline nickel. During the course of this work the experimental tube was accidentally broken when the target was at a high temperature, as a result of which it was heavily oxidized. To get rid of this oxidized layer, it was reduced and removed by vaporization after prolonged heating at very high

temperatures. On continuing the experiments with the same target, it was found that the angular distribution of scattered electrons had completely changed. The alteration was traced to a recrystallization of the target that occurred during the prolonged heating. Before the accident the target surface consisted of many small crystals, after the accident only a few large ones, and the wave nature of electrons can be proved only when they are scattered by large single crystals.

It was, however, Elsasser, who first pointed out in 1925, shortly after the publication of de Broglie's papers, that wave nature of particles would be found in the reaction between a beam of electrons and a large single crystal, and he believed that evidence for the same was obtained from Davisson's experimental curves showing the angular distribution of electrons scattered by a target of platinum.

Early in 1927, Davisson and his collaborator, L. Germer, published the results of their investigations carried on with homogeneous beams of slow electrons of energy up to several hundred volts, which were allowed to strike the face of a large single crystal of nickel. The intensity of the scattered rays was studied by means of a collector of the Faraday cylinder type. With any initial azimuthal setting of the crystal, its rotation produced a number of peaks in the intensity distribution of scattered rays of electrons, the appearance of these maxima itself being an indication of some sort of waves. Davisson went further and showed that the values of wavelength given by substituting their experimental values of θ in the Bragg formula $n\lambda = d \sin \theta$ were in agreement with those given by de Broglie law, so that their experiments afforded full confirmation of the existence of de Broglie waves.

G. P. Thomson's work

G. P. Thomson was born in England in 1892, and was educated at Cambridge, where he obtained first class in the mathematical and natural science tripos. It rarely happens that a distinguished person can see his own son distinguish himself in the same line. Such however has been the lot of Sir J. J. Thomson. G. P. Thomson is the illustrious son of a more illustrious father, who also was awarded the Nobel Prize in physics as early as in 1906, for his famous researches on the ionization of and conduction through gases. So far as Nobel Prize award in concerned, the only other similar instances are those of W. H. and W. L. Bragg and the Curies and their daughter Iréne Curie Joliot. It is remarkable indeed that G. P. Thomson's work has produced brilliant confirmation of the wave nature of cathode ray corpuscles, which were first proved to be discrete material particles as a result of the brilliant researches carried on by his father nearly forty years ago.

G. P. Thomson studied the diffraction of electrons transmitted through thin films. The first experiments performed under his directions in Aberdeen, in 1927 consisted in sending a beam of electrons from a discharge tube through a narrow hole, behind which was placed a thin film of celluloid and the beam was then allowed to fall on a photographic plate normal to it. Besides the central spot, some diffuse rings were obtained demonstrating the wave nature of electrons, passing through a cloud of scattering centres. Following upon this work, Thomson performed similar experiments with metal films of known crystal structure and in all cases the pattern obtained on the photographic plate consisted of a series of rings concentric with the undiffracted spot, as are obtained by Debye-Scherrer powder method with X-rays. The sizes of the crystal axes for various metals were calculated from de Broglie relation $\lambda = \frac{h}{mv}$, and they were found to coincide with those found by X-rays.

Thomson later developed methods of obtaining diffraction patterns by reflection of electron beams from single crystals and polycrystalline surfaces. These methods have opened up new possibilities for the examination of surface structures, being much more advantageous than X-ray methods as they are much less penetrating, and interacting more intimately with the atoms of the substances under investigation, than X-rays. Later workers have employed these methods of electron diffraction in studying the nature of liquid films and also of many organic vapours, and many knotty problems concerning the structure of their molecules have been satisfactorily solved.

S. Datta.

Notes and News

Morton Mains Disease

Absence of a trace of cobalt was the cause of a deficiency disease which attacked the sheep in some parts of New Zealand, during the last 25 or 30 years and was the cause of much loss to the sheep farmers. The disease got its name Morton Mains disease from the locality where it appeared with perhaps the greatest virulency. The diseased sheep when transferred to a locality where this disease was unknown came round rapidly and the healthy sheep brought from a healthy place to the diseased area remained healthy but the next crop of lambs of such healthy parents were liable to be attacked by this disease, though the climate and the vegetation of the two places were similar. This suggested that the disease was caused by the absence of some elements from the soil of the place where the disease flourished. On a spectroscopic examination of the two soils, the soil of the healthy locality was found to contain ·0002 p. c. nickel and ·0007 p. c. cobalt, whereas the soil of Morton Mains did not contain these two elements. By administration of small doses of cobalt (1 milligram per day) to the sheep the disease was completely eradicated.

Heavy Nitrogen

In 1934 Prof. H. C. Urey obtained the Nobel Prize in Chemistry for the discovery of heavy water. On the 6th September 1936 at the Congress of the American Chemical Society he announced that he had been able to obtain heavy nitrogen in sufficient quantity for research work. The atomic weight of the new isotope is fifteen times that of hydrogen.

Urey's process permits to obtain 160c^3 of heavy nitrogen per day. It is expected that heavy nitrogen would be very suitable for researches in physiological chemistry specially on the metabolism of proteins.

Radioactive Isotope of Potassium and the Age of the Earth

There exists a radioactive isotope of potassium of atomic weight 40 (whilst that of potassium is 39). As it is transformed at the end of a very long time into calcium this furnishes a means of calculating the approximate age of the earth based on the quantity of calcareous rocks present in the earth's crust. According to Dr A. Keith Brewer of the Bureau of Chemistry of U. S. A., the age of the earth evaluated by this method will not attain 3 milliard years. The solidification of the crust had taken 1,430,000,000 years; analogous calculation based on uranium-radium-lead ratio leads to 1½ milliard years.

Meteorite Collections of the Indian Museum

The meteorite collections of the Geological Survey of India are the best, says Dr Coulson of the Survey in course of a popular article, in Asia and ranks fourth or fifth in the whole world. They comprise some 475 falls, of which 299 are stone and 176 are iron. They are housed in three fine cases in the Indian Museum, Calcutta. Every endeavour is made to augment the collections by recovery of all material it is possible to obtain and by exchange. The Geological Survey of India earnestly requests the co-operation of individuals and local officials in the collection and preservation of this very valuable tangible evidence of the universe around us. The value of each fall varies according to a variety of circumstances, such as the total weight recovered, its peculiar composition, the number of possessors of specimens, whether the fall was witnessed, etc.

Archaeological Excavations at Khokrakot and Kausambi

Archaeological excavations have just been started at Khokrakot, near the town of Rohtak in the Punjab, and at Kosam, which has been identified as the site of the ancient city of Kausambi, near Allahabad. There is at Khokrakot an extensive mound of ancient origin and it is hoped that the survey now started in the South East Punjab and Western U. P. will throw some light on India's ancient history, which is particularly obscure in the period between the prehistoric Indus culture, and the

historic age commencing with the birth of Buddhism in the Lower Gangetic Basin. Excavations at Kansambi are also likely to prove of the greatest interest, for Kansambi was one of the earliest historic sites, and it is believed that its foundation rests on the settlement of an earlier period. Already two heards of cast copper coins which were in use in the early centuries of the Christian era have been discovered in the excavations and the place bids fair to be the richest site for antiquities in Northern India.

Atom Tracks Exhibition at Kensington

It is now twenty five years since Professor C. T. R. Wilson first succeeded in making visible the tracks of individual atoms and electrons. Before this time methods had been devised for detecting single atoms as they struck a small screen or entered a small box, but by Wilson's method the actual paths pursued by flying atomic nuclei and electrons can be seen and photographed, their collisions one with another can be studied and even the transmutation of one element into another can be observed. Wilson's expansion chamber method has been very widely used for investigating the structure and behaviour of atoms, and an exhibition has been arranged at the Science Museum to illustrate the great variety of effects which have been investigated by the method during the past 25 years. The centre piece of the exhibition is C. T. R. Wilson's original apparatus of 1911-12, which has been lent by the Cavendish Laboratory, Cambridge, where Wilson's pioneer work was carried out. The remainder of the exhibition consists of a collection of over 80 photographs which have been taken by research workers all over the world using Wilson expansion chambers. An introductory group of twelve photographs illustrates in as simple a way as possible some of the main properties of alpha-rays, beta rays, X rays and cosmic rays, for the benefit of those who are not familiar with them. The collision of an alpha ray with an atom of hydrogen can be seen - an example of what may be termed "atomic billiards" while in a neighbouring photograph an alpha-ray is seen to disintegrate the nucleus of a nitrogen atom, ejecting from it a proton which flies off at high speed. These and many other of the photographs have been furnished with key diagrams, so that their essential features can be readily picked out even by the visitor who is relatively unfamiliar with the subject.

Indian Statistical Conference 1938

The opening ceremony of the First Session of the Indian Statistical Conference will be held in Calcutta in the Senate Hall of the Calcutta University at 10 a.m. on Friday the 7th January, 1938. Prof. R. A. Fisher, Sc.D., F.R.S., Galton Professor in the University of London, will be the General President. There will be one afternoon session on Friday, the 7th January and two sessions, one from 9-30 a.m. to 12-30 p.m., and the other from 2 0 p.m. to 4-30 p.m., on the 8th and 9th January 1938. The work of the Conference will be carried on in active co-operation with the Indian Science Congress which will also meet in Calcutta at the same time, and arrangements have been made for two joint discussions with the Indian Science Congress, one on agricultural statistics and the other on theoretical statistics. One or possibly two sessions will also be devoted to economic statistics and one session to public health and vital statistics.

The Government of India have very kindly given their official recognition to the Conference, and have agreed to permit officers under their control to attend it and to draw travelling allowance for this purpose on the same terms and conditions as officers who are permitted to attend the Indian Science Congress.

The minimum subscription for the membership of the Conference has been fixed at Rs. 10/-. Members of the Indian Statistical Institute and delegates will be entitled to become ordinary members of the Conference without payment of any fees. All members of the Conference will have the right to contribute papers, to attend all scientific and other meetings of the Conference, and to receive free of charge all publications relating to the Conference. Associate members who will have the right of attending all scientific meetings of the Conference will also be enrolled on payment of a minimum subscription of Rs. 2/- for the session. Persons desirous of attending the Conference are requested kindly to communicate with the Honorary Secretary as early as possible. Visitors from outside Calcutta are requested kindly to give early intimation of accommodation required, mentioning date and time of arrival, nature of food (vegetarian or non-vegetarian) and class of accommodation.

Science in Industry

Minerals in India in 1936

According to the *Records* of the Geological Survey of India, the total value of minerals produced during 1936 in India (including Burma) was nearly £19,500,000, an increase of nearly £81,000 over the previous year's figures. There was, however, a decrease in the value of the output of the two principal minerals of the country, *viz.*, coal, (4.2%) and petroleum (0.7%), though the actual amount of petroleum produced increased to about 335,000,000 gallons, the highest figure yet recorded for the industry. Coal output during the year was a little over 22,500,000 tons (a decrease of 1.8% in quantity) valued at nearly 6¼ crores of rupees (£4,700,000). The true cause of the depression in the Indian coal industry is, according to the *Records*, over-development of the coal fields, with reference to India's requirements. Every new coal field that is opened at present merely serves to accentuate the depression. Of the thirteen other minerals with outputs valued at over £100,000 annually, increases in value were shown by manganese ore (46.3%), lead and lead-ore (25.6%), mica (14.2%), iron-ore (13.2%), zinc concentrates (6.2%), nickel speiss (5.9%), tungsten concentrates (3.7%), tin concentrates (2.3%), and gold (0.7%), while decreases were shown by silver (32.6%), salt (14.9%), building materials (7.9%), and copper-ore and matte (2.1%).

Metric System in Industry

A detailed examination of the use of the metric system and its further possibilities in the chemical industry is announced by the Decimal Association. It is pointed out that the metric system is already in use in part in a number of industries, and that the Association would welcome the co-operation of any firm willing to supply information as to the application of the system in their own concerns. By such co-operation it is hoped to compile a comprehensive survey to be used in the Association's efforts to secure decimal reform for Great Britain. The Decimal Association is now keenly supported by over 600 industrial concerns including a number in the chemical industry.

— *The Chemical Age.*

Drug Industry in India

"The Future and Prospects of Drug Industry in India" by Dr B. Mukerji and Dr J. C. Gupta forms the next article in our Section of 'Science in Industry.' For the past few years the drug industry in this country has been occupying the mind of both the general public and the industrialist, as also of the Government. Though attempts have been made occasionally to tackle the problems connected with the industry, they have so far lacked co-ordination, and little has been achieved either to create the market for the indigenous products of India or to improve the quality and standardize it (though the Government have recently taken definite steps in the latter direction). There is no dearth in India of qualified chemists and pharmacologists; raw materials for manufacturing drugs are abundantly produced in this country. All that is therefore needed to utilize these and develop the industry on sound lines is suitable capital and initiative. For want of space we have been able to publish only half of the article; the other half will appear in the next issue. We hope it will be welcome, especially as it comes at this opportune moment.

The Future and Prospects of Drug Industry in India

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The drug manufacturing industry is one among many others, which have suffered from comparative neglect. Next to the supply of cheap and substantial food, the provision of medicines of good and dependable quality at a price within the reach of the poverty-stricken masses is an urgent necessity. The drug manufacturing industry, therefore, is one of the most essential and vital of all industries, and is so intimately associated with medical and public health work that it demands the special attention of all interested in a better and healthier India.

The drug industry has never made a great head way in India, and the reason is not far to seek. Before the introduction of the Western system of medicine, the indigenous systems, *e.g.*, the Ayurvedic and the Unani and Tibbi systems of medicine, held the field. Nearly 90 per cent. of the population of the country relied on these old systems of treatment in some form or other and on the indigenous materia medica. It was, therefore, no wonder that even at the beginning of this century, there was little demand for Western scientific medicines. Within the last 30 years, a distinct change in this state of affairs is noticeable. The Western system of medicine with its real triumphs in the field of immunity, serotherapy, specific medication, chemotherapy, etc., has proved its merit beyond all doubt, and has gradually established a firm hold in the minds of the people. The wonderful achievements in the field of surgery and obstetrics, coming at a time when the ancient indigenous system of treatment in India was almost in a stagnant and paralytic condition, naturally created a very great beneficial influence. The people began gradually to change their old faiths in the healing properties of the crude decoctions and infusions, charms and amulets, etc., and slowly but surely adopted the teaching and practices of the new and progressive Western system of treatment. This system has now gained enormous popularity in India and its adherents are increasing every day in number. The demand for medical facilities is so widespread now that the supply of medicine has already fallen far short of the demand, with the result that medical treatment is becoming more and more costly every day indeed far too costly for the average individual in a poor country like India.

Import of Medicinal Drugs and Chemicals in India

That there is a large and rapidly growing demand in India for medicinal drugs and patent and proprietary medicines belonging to the Western system of medicine is seen clearly from a perusal of the sea borne trade statistics of British India.

TABLE*

Drugs and Allied Medical Products Imported into India

(Value in rupees)

	1931-32	*1932-33*	*1933-34*	*1934-35*	*1935-36*
(1) Pharmacopoeial drugs ..	71,97,274	82,87,009	88,03,112	77,64,027	1,84,34,360
(2) Essential oils	9,20,381	11,07,526	10,83,384	12,58,893	15,43,273
(3) Proprietary medicines ..	46,90,562	37,68,824	30,97,635	39,26,150	26,82,178
(4) Medicinal chemicals (excluding manures and medicines) ..	2,56,97,248	2,71,24,967	2,70,05,640	2,92,39,278	3,11,88,350
(5) Toilet products	47,79,746	58,13,685	56,61,474	64,05,314	66,06,351
(6) Alcohol (for use in medicines and drugs)	30,98,786	32,80,734	33,82,330	36,51,077	38,34,246
(7) Spirits for perfumery ..	5,80,566	4,88,114	6,86,903	7,59,414	7,33,289

* Adopted from the Sea-borne Manual of British India.

The table is self explanatory and needs no special comment. It is apparent that since 1931, there is as distinct tendency for practically all the items in the list to show a well-marked increase. This increase is not just a temporary state of affairs. If we look further back to the records and statistics of trade returns, we find definite evidence that a steady increase of imports is going on for a pretty long time. Thus in the year 1908-9, the value of imported drugs was only about 73 lakhs, in the year 1935 6 it went up to nearly 273 lakhs, a fourfold increase in the short period of 25 years. These figures, of course, do not take into account the drugs manufactured in the country, and though exact statistics are not available, there are evidences to show that this is not an insignificant figure and may be as much as 20 to 25 per cent of the imports. The only hopeful feature which is evident from an analysis of the table appears to be the tendency to decrease of the import figures under the head 'proprietary medicines.' While this may be considered as a sign that indigenous manufacture is gradually replacing the imported specialities, it is more likely that it is due to the general financial depression and the economic uncertainty in India during recent years affecting the buying capacity of the people. The craze for using proprietary and patent specialities is so universal amongst the medical practitioners, and there is so much propaganda in their favour that there is every possibility that there will be a substantial increase under this head in the near future.

We have purposely included in the table figures for 'Essential Oils,' 'Alcohol (medicinal),' 'spirits for perfumery' and 'toilet products' as these are intimately connected in many ways with the problem of drug manufacture, at least in India and should be considered in every well-planned scheme for the promotion of this industry in India. We will consider this aspect of the question, in more detail, later.

Drug Resources of India

The drug resources of India are vast and inexhaustible. It may be said, without much exaggeration, that with suitable opportunities, India can supply the whole world with medicinal herbs and drugs. Leaving aside for the time being the large number of drugs used in the indigenous systems of medicine in India, nearly three-fourths of the vegetable drugs mentioned in the British and United States Pharmacopoeia grow wild and in great abundance in the different parts of India. India, as we all know, has been called the epitome of the world and indeed she possesses such wonderful variability of temperature, soil and climatic conditions that every conceivable drug ranging from those growing in the hottest tropical climate to those growing in temperate and cold climates may be made to grow in her soil. Moreover, a large number of plants grow in India which, though not exactly the same, have properties and actions similar to the imported and often expensive remedies, and would form excellent substitutes. Not infrequently it is some closely allied species which is pharmacologically just as active. Examples of such drugs are numerous but a few important ones such as *digitalis, ipecacuanha, eucalyptus, cinchona, jalap* etc., may be cited. They were introduced into India many years ago and are doing well. Nature has bestowed with a bounteous hand all the medicinal drugs and herbs which her people require. In spite of this she is dependent on many foreign countries for her vegetable drug requirements. Even to this day, crude drugs like podophyllum, colchicum, squills, ergot, belladonna, etc., are being brought in from America, Russia, and Spain. Finished preparations like tinctures, solid extracts, etc., in fairly large quantities are also coming in. Many Indian firms manufacturing pharmacopoeial tinctures and other galenical preparations of a similar nature import the solid extracts from foreign drug houses and carry out the required dilutions in this country and label the products thus obtained as their own indigenous manufacture. Apart from drugs of vegetable origin, India is hopelessly dependent for almost all her pure and heavy chemicals, used in medicine and pharmacy and in analytical and scientific work on Germany, Great Britain and Japan. Practically the whole range of anaesthetics, both for local and general use, the whole group of synthetic preparations, the constantly growing series of preparations for radiological purposes, all the essential oils, vitamin and endocrine products, to mention only a few, must come from abroad to maintain the health of her countless millions. Practically all the fine chemicals and basic alkaloids like strychnine, atropine, caffeine, etc., are derived from foreign countries. It is not impossible to manufacture all these requirements in our own country. By means of a few concrete examples we

wish to show how this is possible. Thus, *Atropa belladonna*, the source of all belladonna preparations of the pharmacopoeia and the alkaloid, atropine, grows in great abundance in the Himalayan ranges extending from Simla to Kashmir at an altitude of 6,000 to 12,000 feet above the sea level. An unlimited supply of the leaves and roots can be obtained from the northern Himalayas from localities not too far away from places with suitable transport facilities. Large quantities of the root are collected in the Hazra district of the North Western Frontier Province and during recent years, have been exported to Europe and America. The Indian Belladonna roots have been found to contain a higher percentage of total alkaloids (0.81 per cent.) as compared with the standard (0.45 per cent.) laid down in the British Pharmacopoeia. In spite of such advantages, India imports fairly large quantities of Belladonna preparations and the alkaloid, atropine. Another important source of atropine which has not been properly exploited is the plant, *Datura*. India is the only country where both *Datura stramonium* and *Datura fastuosa* grow plentifully. In Bengal, *Datura* is found almost at the doors of every householder in the villages. Because of its easy availability, it has been most neglected and most of the *Stramonium* preparations in the market and 'asthma specifics' of which the chief constituent is stramonium, are imported from outside. The atropine content of this plant is undoubtedly low but the plant grows so abundantly in easily accessible localities that it will be worthwhile to attempt extraction of the alkaloids from the plant. *Strychnos nux vomica (Vern. Kuchila)* grows wild and plentifully throughout tropical India up to an altitude of 4,000 ft above sea level. It is particularly abundant in the Madras Presidency, Cochin, Travancore and in Orissa. In the Mayurbhanj State in Orissa, Nux vomica trees flourish and a good export trade in the seeds is already existing. The total exports from India approximate to about 45,000 50,000 cwt. annually, valued at Rs. 3,00,000 (3 lakhs) and they go almost entirely to Great Britain. Galenicals like tinctures and extracts and purified alkaloids—strychnine and brucine—are manufactured there and sent out to the Indian market. The value of the imported refined products is nearly 100 times greater than that of the exported Nux vomica seeds. There seems no reason why the manufacture of tinctures for medicinal purposes and the alkaloid, strychnine, could not be profitably undertaken in India. Tincture Nux vomica is widely used in general tonic prescriptions, and strychnine, apart from its medical use, is largely employed as insecticide and as an animal poison in countries like Australia and New Zealand. If the Nux vomica seeds are available in the Calcutta factories at a cheap rate and if factories are erected near the source of supply of the drug, strychnine could be easily manufactured at competitive prices. Santonine is another important drug which may be economically manufactured in India. Practically all the santonine in the Indian market is imported from outside. Many species of *Artemisia* grow in the Himalayas, particularly in the valleys of Kashmir and in the Kurram Agency in the N. W. Frontier Provinces. They yield quite as good santonine as could be derived from the Artemisia growing in Russian Turkestan. Quite a large quantity of the flower heads is now collected in India and exported to England for the manufacture of the finished product. Santonine is a very expensive drug, and if arrangements could be made for a large scale production of the drug in the localities where artemisia is growing, a remunerative industry can be easily built up. Caffeine is another important drug in the armamentarium of the physician. It is the principal alkaloid occurring in tea and coffee plants, both of which are found in abundance in India. Next to China, India is the largest tea-growing country in the world. Every year nearly 360 million pounds of tea are used for local consumption in India and Burma. If caffeine is manufactured from the tea waste (fluff and sweepings) derived from the quantity of finished tea exported, nearly 57,300 lbs. of caffeine can be produced which will fetch a substantial sum. The demand for caffeine and its salts all over the world is quite large, and India, the largest tea-exporting country in the world, can easily hold the key to the caffeine industry of the world. Morphine and its preparations provide another instance of our hopeless dependence on foreign countries. Most of the salts of morphine and preparations of codeine met within India and used for pharmaceutical purposes are under the label of foreign manufacturers, though India undoubtedly is one of the important opium growing countries in the world. Castor-oil seeds and chaulmoogra seeds which are abundantly available both in India and Burma are taken thousands of miles

(*Continued on Page 3..*

Research Notes

The Surface Wave in Radio Propagation over Plane Earth

In 1907 Zenneck (*Ann. der Physik*, Ser. 4, Vol 23, Sept. 20, 1907) showed that a plane interface between two semi-infinite media such as the ground and air could support an electro-magnetic wave along the surface. This "surface-wave" of Zenneck received a theoretical support from Sommerfeld's solution of the problem in 1909 (*Ann. der Physik*, Ser. 4, Vol 28, March 16, 1909). The solution contained a cylindrical surface wave which at great distances is analogous to the Zenneck wave.

Later in 1919 Weyl (*Ann. der Physik*, Ser. 4, Vol 60, Nov. 20, 1919) obtained a solution which did not explicitly contain the surface wave in question. His results as well as the theoretical expressions obtained by van der Pol and Niessen (*Ann. der Physik*, Ser. 5, Vol 6, Aug. 22, 1930, Vol 10, July 21, 1931, Vol 18, Dec. 24, 1933, Vol 16, April 1933, *Physica*, Vol 2, Aug. 1935) were considered numerically equivalent to Sommerfeld's results. Sommerfeld in 1926 published further theoretical results on the problem (*Ann. der Physik*, Ser. 4, Vol 81, Dec. 11, 1926). Rolf (*Proc. I. R. E.*, Vol 18 March 1930) constructed graphs from Sommerfeld's earlier paper showing the variation of the field with distance covering all practical ground conditions. These curves were accepted except for minor criticism by Wise (*Proc. I. R. E.*, Vol 18, Nov. 1930).

In 1935, however, Norton (*Nature*, Vol 135, 1935, June 8) pointed out that Rolf's graphs were constructed from Sommerfeld's solution as given in the earlier paper which contained an error in sign—an error which did not however occur in the later paper. Norton himself (*Proc. I. R. E.*, Vol 24, Oct. 1936) deduced formulae for ground-attenuation of radio waves from short grounded antennae which did not agree with the Rolf curves. C. R. Burrows (*Nature*, Vol 138, Aug. 15, 1936) also showed that the results of Weyl were not in agreement with those of Sommerfeld-Rolf but actually differed from Sommerfeld by exactly the surface wave component. Wise (*Bell. Sys. Tech. Jour.*, Vol 16, Jan. 1937) and Rice (*Bell. Sys. Tech. Jour.*, Vol 16, Jan. 1937) theoretically showed that simple antennas do not generate a surface wave component. Burrows (*Proc. I. R. E.*, Vol 25, Feb. 1937) reported that his experiments over deep fresh water showed that the surface wave component is not set up by simple antennae. His measurements agreed with the curves calculated by neglecting the surface wave component. The recent theoretical study of Norton (*Phys. Rev.*, July 15, 1937 p. 132) however clearly indicates that the radiation over the plane earth consists of a space wave and a surface wave and that the surface wave is just the ground wave which is the medium for radio frequency communication. Norton's "surface wave" however has an attenuation factor which varies at first exponentially with the "numerical distance" and finally at large distances inversely as the "numerical distance." The recent experimental results of Feldman (*Proc. I. R. E.*, Vol 21, 1933), and Burrows (*Proc. I. R. E.*, Vol 25, Feb. 1937) have been found to agree with Norton's formulae. Recent attenuation measurements by Khastgir & Chakravarty at Dacca with ultra-short waves also support Norton's formula.

Norton, however, derived his formulae from a formula of van der Pol and Niessen. Further experimental results on the subject of surface wave component are awaited with interest.

M. K. Chakravarty.

Diphtheria Toxin and Vitamin C

It is known that the vitamin C reserves of the adrenals of guinea pigs dying from the effects of diphtheria toxin are greatly diminished and that test animals partially depleted of vitamin C

survive the injection of this toxin for shorter periods of time than those fed on adequate diet. It was also claimed by some workers that diphtheria toxin also is destroyed by solutions of ascorbic acid, *in vitro*, under certain conditions. These findings gave rise to assumption that vitamin C neutralizes the diphtheria toxin within the system. C. C. Torrance (*J. Biol. Chem.*, *121*, 31, 1937) undertook experiments to verify the above assumption which evidently postulates combination of the toxin and the vitamin and consequent inactivation of the ascorbic acid. The author finds that although the vitamin C content of mixtures of lemon juice and toxic filtrates of the diphtheria bacillus progressively declined, the ascorbic acid was found to have ***no effect*** upon the toxin in the p_H range of the mammalian tissue. The apparent destruction of the ascorbic acid is due to its oxidation to the dehydroxy form.

H. N. B.

New Anthropological Instrument

J. C. Trevor and M. F. Ashley-Montagu have devised a new slide compass, which was demonstarted before the American Association of Physical Anthropologists, Cambridge, on April 10, 1937. This instrument differs from the old slide compass of Martin, mainly in the presence of a device which helps the experimenter to measure internal diameters. The instrument is made of brass chromium plated and the weight of the instrument is about 5 ounces. This instrument is made by Mr Walter Turnbull, head of the Machine Shop of New York University, Washington.

M. N. Basu.

The Middle Atmosphere

Up to a height of about 10 kilometers our atmosphere is governed by adiabatic laws, and it is believed that practically all the meteorological phenomena belong to this shell of gaseous mantle surrounding the solid sphere of the earth. Again, from the long-distance transmission of radio waves, it is known that earth's atmosphere does not terminate at a height of 10 kilometers only but rises up many times to this height. Thus beyond 100 kilometers the existence of two main regions of stratification, the *E* and *F* layers, was established from radio researches. Thus the two regions of the atmosphere, the first up to 10 kilometers and the other beyond 100 kilometers were considered to be of very great interest, the former to the meteorologist and the latter to the radio engineers. The intermediate region—the region between 10 to 80 kilometers—was left to the investigators who were busy on problems purely from the standpoint of gaining more land from the regions of the vast unknown. This region is generally termed as the lower ionosphere or the middle atmosphere.

An interesting feature of this middle atmosphere is that its temperature instead of falling with height as in the case of lower atmosphere remains practically constant at about 220°K up to near about 30 kilometers and then rises up, more or less sharply, to the height of approximately 65 kilometers reaching a value near about 450°K. After this it falls down with height till about 80 kilometers, the rate of fall being 280° in 20 kilometers. (Martyn and Pulley, *Proc. Roy. Soc.*, Vol 154, p 455, 1936; E. Kidson, *Quat. Journ. Roy. Met. Soc.*, Vol 63, p 477, 1937) Another very important feature of this middle atmosphere is that it embodies the "ozone layer" (25–50 Km.), the layer that is responsible for the removal of the entire ultraviolet part (quartz) of the solar spectrum beyond λ3000A. Again the phenomenon of meteor trails is observed to remain confined mostly to its outer border (about 85 kilometers).

There exists a general belief that the return of radio waves of measurable intensity from this region is highly improbable in any save exceptional conditions, for the higher rate of recombination is likely to prevent the maintenance of substantial ionic densities. One of these exceptional conditions is found out to be solar radiation and the investigators have many a time detected a more or less diffuse layer of ionization (*D*-layer) at about 60 Km. (Appleton, *Proc. Roy. Soc.*, A. 126, p 558, 1930; Mitra and Syam, *Nature*, Vol. 135, p 953, 1935) forming only in daytime and distinct from the sharply bounded *E* or *F*-regions. R. A. Watson Watt, A. F. Wilkins and E. G. Bowen of the National Physical Laboratory after observations

spread over a year from May 1935 claim to have established the existence of sustained stratified electrification, of such ionization density and gradient as to return radio waves of frequency 6.12 Mc/Sec at vertical incidence at a variety of levels (*Proc. Roy. Soc.*, Vol 161, p 181, 1937) persisting without substantial change of level for at least several days at heights of 8.5, 9.3, 10.3, 10.75 and 13.5 kilometers with reflection co-efficient of the order of 0.7 giving measurable echoes up to the 10th order. Another apparently independent stratification in the middle atmosphere has been identified by these workers at a height of 45-50 Km. with a reflection co-efficient of 0.3 for 6 Mc/Sec frequency waves. They have also detected the already known *D* region at and above 60 kilometers on many occasions at all times of the day both in summer and in winter. They have also recorded that the ionization does not fall to very low values at night and has no seasonal variation of large amplitude.

The implication of these results on the structure and stability of the middle atmosphere is very great, but it is as yet too premature to expect anything final and we are looking forward to the second part of the paper by Watson Watt and colleagues with great interest.

S. C. Deb.

The Future and Prospects of Drug Industry in India

(*Continued from Page 330*)

away for manufacturing refined products. There are crude, antiquated distilleries in existence here and there, but their products are not suitable for pharmaceutical requirements. Nearly 90 thousand pounds of codliver oil valued at about 1½ lakhs of rupees are annually imported into India and the import of codliver oil containing medicinal specialities also reaches a substantial figure. Codliver oil is, of course, not available in India, but there are varieties of fishliver oils, which can be utilized instead as substitutes. Recent researches have revealed that the Indian fishliver oils are useful sources of fat and vitamin, and can compare very favourably in medicinal virtues with imported codliver oils. If an extended use of these oils is made, the economic gain to the country will be immense. Many other examples like the above can be cited, but it is unnecessary to multiply them here.

(To be Continued)

University and Academy News

National Institute of Sciences of India, Calcutta

The Seventh Ordinary General Meeting of the National Institute of Sciences of India was held at 2-30 p.m. on Saturday, the 6th November, 1937, in the Physics Lecture Theatre of the University of Delhi. Prof. M. N. Saha, President, was in the chair.

On the motion of the President the following resolutions were passed by the meeting.

(i) The National Institute of Science of India places on record its deep sense of sorrow and loss to Science owing to the death of Prof. Albert Heim, one of the Honorary Fellows of the Institute, which took place at Zurich on the 31st August, 1937.

(ii) The National Institute of Sciences of India places on record its deep sense of sorrow and loss to Science owing to the death of the great physicist Lord Rutherfold of Nelson, one of the Honorary Fellows of the National Institute, which took place on the 20th October, 1937.

The following gentlemen were elected Ordinary Fellows of the Institute:

Prof. Y. Bharadwaja, Principal B. L. Bhatia. Prof. G. R. Paranjpe, Dr. H. Srinivasa Rao, Dr. K. Rangadharma Rao, Prof. M. R. Siddiqi, Prof. A. C. Sircar, Dr. M. B. Soparkar, Hon'ble Sir Shah M. Sulaiman and Col. F. C. Temple.

The following gentlemen were elected Honorary Fellows of the Institute:

Prof. Ludwig Diels, Sir James G. Frazer, Prof. Robert Robinson and Dr C. M. Wenyon.

The following papers were read: -

1. The O-O-Band of OD by M. Ishaq. 2. The Theory of liquids--by T. S. Wheeler. 3. A study of the behaviour of some common varieties of sugarcane in reference to the attack of borers --by H. S. Pruthi and E. S. Narayanan. 4. Joule-Thomson effect and adiabatic changes in degenerate gas--by D. S. Kothari. 5. The chemical fixation at low temperature and its significance in agriculture--by B. Ramamurthi. 6. The propagation of electromagnetic waves through the atmosphere by M. N. Saha and K. B. Mathur. 7. Joule Thomson expansion of a non-degenerate gas - by B. N. Srivastava.

The National Academy of Sciences, India

The Ordinary Monthly Meeting of the National Academy of Sciences, India, was held in the Physics Lecture Theatre, Muir College Buildings, Allahabad, on the 28th October, 1937, with Prof. B. Sahni, D.Sc., Sc.D., F.G.S., F.R.S., President of the National Academy, in the Chair.

The following papers were read and discussed :- -

1. Prosotocus himalayai n.sp., a Frog trematode (Lecithodendriidae), by B. P. Pande, Zoology Dept., Allahabad University.
2. On an equation for the Viscosity of Mixtures, by S. K. Chakrabertty and P. B. Ganguly, Science College, Patna.

Royal Asiatic Society of Bengal, Medical Section

A Meeting of the Medical Section of the Royal Asiatic Society of Bengal was held in the lecture theatre of the Calcutta School of Tropical Medicine on Monday, the 8th November, 1937.

The following papers were read: -

1. Dr. G. Panja- A Pathogenic strain of staphylococcus citrens.
2. Dr. P. N. Chaudhuri -Exhibition of clinical cases:
   (*a*) A case of tubarachnoid haemorrhage.
   (*b*) A case of spirochaetal jaundice.
3. Dr. D. N. Roy—On some unknown factors in the production of eggs in flies.

Letters to the Editor

On the Distribution of the Means of a certain Bessel Function Population

S. Bose has made a certain study of the following Bessel function distribution :—

$$f(x)dx = Ce^{-ax}x^{m/2}I_m(q\sqrt{x})dx,$$

where $C = (2/q)^m a^{m+1} e^{-q^2/4a}$,

and $q \geq 0$, $a \geq 0$, $m > -1$

This distribution first arose in a specialized form in connection with the researches of the present author on the exact distribution of the D^2- statistic[1]. I have now found the distribution of the mean, of a random sample of n, from this population. It comes out as

$$C'e^{-na\bar{x}}\,\bar{x}^{(mn+n-1)/2}\,I_{mn+n-1}(nq\sqrt{\bar{x}})\,d\bar{x}$$

where $C' = (2/nq)^{mn+n-1}(na)^{n(m+1)}e^{-nq^2/4a}$

Hence the distribution of the mean is of the same type as the mother population. Since the type III distribution is a special case of the distribution investigated here, Irwin's distribution of the mean of a random sample of n, from a type III population, follows as a corollary.

Statistical Laboratory, Raj Chandra Bose.
Calcutta.
29.10.37

1. R. C. Bose : "On the Exact Distribution and Moment Coefficients of the D^2- statistic." *Sankhya*, 2 (2), 1936.

On the Distribution of Fisher's Taxonomic Co-efficient and "Studentized D^2-statistic"

In a paper published lately in the *Annals of Eugenics* (vol. VII, Part II, September 1936 ; pp. 178 188) under the title "The Use of Multiple Measurements in Taxonomic Problems" R. A. Fisher has obtained by the principle of maximization a certain expression based on sample readings, which he calls the taxonomic coefficient, whose object is to test, on the hypothesis of a multivariate normal population, whether two samples can be reasonably supposed to have been drawn from two populations with the same means, it being known or assumed that the two populations have the same variances and co-variances. By certain general arguments and formal analogies with partial regression, Fisher makes the distribution of this co-efficient depend on his z distribution, and then proceeds to numerical applications. We have now by making use of hyperspace geometry and the rectangular co ordinates developed earlier by the authors[1] been able to derive in full the sampling distribution of this co-efficient. It is shown in conclusion that this is in entire agreement with the distribution implied in Fisher's numerical applications but not explicitly given in the *Annals of Eugenics* paper.

When the samples have been drawn from two different populations, the above distribution no longer applies. To estimate in this case the disparity between the two populations we make use of the D^2-statistic in the "Studentized" form[2] with which Fisher's taxonomic coefficient can be proved to be formally identical. Denoting population value of D^2 by Δ^2, we have now obtained the distribution of D^2 in the form

$$\text{Const} \times (1-D^2)^{\frac{p-2}{2}}(D^2)^{\frac{2n-p-3}{2}}e^{-n\Delta^2(1-D^2)}$$

$$\times\ {}_1F_1\left(\frac{2n-p-1}{2},\ p,\ n\Delta^2(1-D^2)\right)d(D^2).$$

where ${}_1F_1$ is the hypergeometric function defined in Watson's *Bessel functions*, p. 100.

Putting $\Delta = 0$, we get the distribution of the taxonomic co-efficient considered above.

Statistical Laboratory, Raj Chandra Bose.
Calcutta. Samarendra Nath Roy.
29.10.37

1. P. C. Mahalanobis, R. C. Bose and S. N. Roy : "Normalization of Variates and the use of Rectangular Co ordinates in the Theory of Sampling Distributions." *Sankhya*, 3 (1), 1-40, 1937.

2. P. C. Mahalanobis : "On the Generalized Distance in Statistics." *Proc. Nat. Inst. Sci.* 2 (1), 49 55.

Anomalous Dielectric Constant of Artificial Ionosphere

In a recent communication in *Nature*, Mitra and Roy[1] have pointed out an interesting feature in the ionospheric dispersion formula. They have shown that the formula can yield values of the dielectric constant of an ionized medium greater, equal to, or less than unity depending on the degree

of ionization, collisional frequency and the exciting wave frequency. They therefore hold that the value of dielectric constant of an ionized gas greater than unity which has been recorded by many investigators for comparatively large ionizations is only an outcome of the complete dispersion formula. The object of this note is twofold. Taking the ionospheric dispersion formula we shall *first* deduce the conditions under which the dielectric constant may assume values greater or less than unity and *secondly* we shall show that in the experiments where anomalous values of the dielectric constant of an ionized gas have hitherto been obtained, the experimental conditions are such that the dispersion formula alone cannot explain the anomaly.

The dispersion formula is given by

$$\left(\mu - \frac{ick}{p}\right)^2 = 1 - \frac{1}{\alpha + i\beta}, \quad \text{where } \alpha = \frac{mp^2}{4\pi Ne^2} \text{ and } \beta = \frac{mp\nu}{4\pi Ne^2}$$

Separating the real and imaginary parts we have

$$\mu^2 - \frac{c^2k^2}{p^2} = 1 + \frac{\alpha}{\alpha^2+\beta^2} \quad \dots \quad (1)$$

and

$$\frac{2ck}{p}\cdot\mu = \frac{\beta}{\alpha^2+\beta^2} \quad \dots \quad (2)$$

Thus $\frac{c^2k^2}{p^2} - \mu^2 = \frac{|\alpha|}{\alpha^2+\beta^2} - 1$ so that

$\mu^2 \gtrless 1$ according as $\frac{c^2k^2}{p^2} \lessgtr \frac{|\alpha|}{\alpha^2+\beta^2}$,

which is equivalent to the condition

$$\mu^2 \gtrless 1 \text{ if } \frac{\mu^2c^2k^2}{p^2} \lessgtr \frac{|\alpha|}{\alpha^2+\beta^2}$$

but as $\frac{\mu^2c^2k^2}{p^2} = \frac{\beta^2}{4(\alpha^2+\beta^2)^2}$ from (2)

the condition reduces to—

$$\mu^2 \gtrless 1 \text{ if } \frac{\beta^2}{4(\alpha^2+\beta^2)^2} \lessgtr \frac{|\alpha|}{\alpha^2+\beta^2} \text{ or } \frac{\beta^2}{\alpha^2+\beta^2} \lessgtr 4|\alpha|$$

Now the left-hand side is always a proper fraction therefore if $4|\alpha| > 1$, *i.e.* $|\alpha| > \cdot 25$

we have then always $\frac{\beta^2}{\alpha^2+\beta^2} < 4|\alpha|$, *i.e.* $\mu^2 > 1$

If however $|\alpha| < \cdot 25$

$\mu^2 > 1$ will require the further condition

$$\frac{\beta^2}{\alpha^2+\beta^2} < 4|\alpha| \text{ or } \beta^2 < \frac{4|\alpha|\alpha^2}{1-4|\alpha|}.$$

Calling $\frac{\pi Ne^2}{m} = p_0^2$ or $p_0 = \sqrt{\frac{\pi e^2}{m}}\sqrt{N} = 2{\cdot}8\times10^4\sqrt{N}$

we have $4|\alpha| = \frac{p^2}{p_0^2}$ and we can say that if

$$p > p_0 = 2{\cdot}8\times10^4\sqrt{N}$$

μ is always less than unity, whereas if $p < 2{\cdot}8\times10^4\sqrt{N}$ or $|\alpha| < \cdot 25$, for $\mu^2 > 1$, we must have

$$\beta^2 > \frac{p^4}{p_0^2 - p^2},$$

i.e., the collisional frequency must exceed the value

$$\frac{p^2}{4\sqrt{p_0^2-p^2}}$$

Thus the equations show that even when $p < 2{\cdot}8\times10^4\sqrt{N}$ there exists a critical collisional frequency which has to be exceeded if μ is to be greater than unity.

In the experiments recently performed in this laboratory, we have obtained results similar to those of Appleton and Childs.[2] Using a wavelength of about 3·8 metres the dielectric constant of ionized air in a discharge tube has been

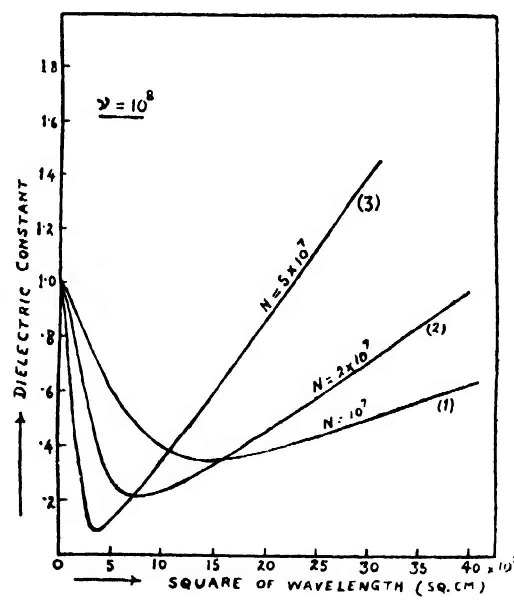


FIG. 1.

found to be less than unity when the tube current is small. As the ionization is increased by increasing the tube current, the dielectric constant at first decreases and then increases gradually and even becomes greater than unity. The maximum electron density N in our discharge tube has been within 10^7. Taking $N = 10^7$, $p = 5\times10^8$, we get $|\alpha| =$

This is much greater than ·25 so that the dielectric constant must be less than unity. Even when $N=10^{6}$, $|a| = 78$ and the dielectric constant should be theoretically less than unity.

In fig. 1 are plotted the calculated values of the dielectric constants against λ^2 for some definite values of N and p. Curve (2) which corresponds to Mitra and Banerjee's[3] experimental conditions shows a turning point at λ of the order $9m$ (λ^2 is of the order 8×10^{8} sq. cm.) which is very different from the experimental value λ of the order $6m$ (λ^2 is of the order $3{\cdot}6\times10^{8}$ sq. cm.) In the experiments of Ali Imam and one[4] of us, which have been recently repeated by a different method, the turning point appears unmistakably at λ of the order $4m$ (λ^2 is of the order $1{\cdot}6\times10^{8}$ sq. cm.). Curve (1) which approximately corresponds to our experimental conditions shows however the turning point at λ of the order $12m$ (λ^2 is of the order 14×10^{8} sq. cm.). It appears extremely doubtful if the disposition of the experimental apparatus can account for such wide discrepancy. It is likely that there must be some other explanation of these experimental results.

Physics Department,
Dacca University.
13.11.37

S. N. Bose.
S. R. Khastgir.

1. Mitra & Roy, *Nature*, *140*, 586, 1937.
2. Appleton & Childs, *Phil. Mag.* *10*, Dec. 1930.
3. Mitra & Banerjee, *Nature*, *136*, 512, 1935.
4. Imam & Khastgir, *Phil. Mag* May 1937 and *Ind. Jour. of Physics*. *10*, Part 1, Feb. 1937.

Role of Argon in the Emission of Swan Bands

Merton and many others[1] have studied the effect of inert gases on spectra of many elementary substances, such as hydrogen, carbon, oxygen and others. Johnson and Cameron[2] have investigated the effect of argon and other inert gases on certain molecular spectra of carbon, oxygen and sulphur. Johnson[3] in a later paper has shown that in a discharge tube of 'H' pattern, having a capillary and fitted with carbon electrodes, green light of exceptional brilliance is emitted, if the tube be filled with argon at a pressure of about 30 mms. This stage comes only when the tube is in the right conditions. In this connection, Johnson and Tawde[4] have indicated the necessity of studying quantitatively the appearance of Swan system with various pressures of argon in a discharge tube. A detailed and systematic study of the intensity changes that take place in the Swan bands under the influence of argon was, therefore, undertaken, and many interesting results have been obtained.

The bands system was excited in discharge tubes of the usual 'H' type having one carbon electrode and one aluminium electrode, together with the side bulbs containing P_2O_5 and KOH. For removal or admission of hydrogen, a palladium regulator was attached to the tubes. The bands system was photographed from the discharge tubes filled with argon at five different pressures (namely, 10, 15, 20, 25, and 30 mms). Intensities of the bands of C_2 (Swan) system were measured by methods of photographic photometry using a calibrated step slit and a standard lamp. The experimental technique has been fully described by various authors, such as Read and Johnson,[5] Johnson and Tawde[4] and Johnson and Dunstan[6].

Results of experiments for all the five pressures show that the distribution of intensity in the Swan system is generally in agreement with the main predictions of the Franck Condon Principle. It may be noted that intensity values for 15 mms pressure correspond very nearly to the available data of Johnson and Tawde[4]. The results further enabled us to get the critical pressure of argon as 2·3 mms for the appearance of (0,0) band of the system which is the strongest. This pressure is sufficiently high for the purposes of explanation of the possible excitation of C_2 on the basis of Klein and Rosseland's theory of inelastic collisions of second kind.

We may postulate the existence of CO as the initial product in the discharge tube, which, after the introduction of argon gas, is dissociated by the energy of the excited argon atoms into oxygen and excess of C_2 molecules, the latter of which are excited simultaneously. A good deal of evidence has been furnished from the experiments in support of this view which it is impossible to record in this short note. Another interesting result is the coincidence of the minimum wavelength of the positions of the intensity centres of the system with the maximum of temperatures calculated on the basis of Maxwell Boltzmann distribution of vibrational energy and this corresponds to about 15 mms, pressure of argon. These and many other interesting peculiarities have been found and will be given in details in a separate paper to be published elsewhere.

Royal Institute of Science,
Physics Laboratory,
Bombay.
21.9.37

N. R. Tawde.
D. D. Desai.

1. Merton, *Pro. Roy. Soc.*, (A) *98*, 225, 1920. *Pro. Roy. Soc.*, (A) *96*, 382, 1920.
2. Johnson & Cameron, *Pro. Roy. Soc.*, (A) *103*, 383, 1923.
3. Johnson, *Phil. Trans.* (A) *226*, 153, 1927.
4. Johnson & Tawde, *Pro. Roy. Soc*, (A) *137*, 375, 1932.
5. Read & Johnson, *Phil. Mag*, *11*, 1152, 1931.
6. Johnson & Dunstan, *Phil. Mag.* * *16*, 472, 1933.

LETTERS TO THE EDITOR

Radio Fadeouts and Solar Eruptions

In several communications recently published in *Nature* and some American journals, it has been pointed out by several observers[1] that the radio fadeouts which occur simultaneously with the occurrence of bright hydrogen H_α-emission in the sun are due to the increase of electron or ion-density below the *E* layer. This conclusion is reached from the observations that the echoes which are received from *E* and *F*-regions retain the same characteristics before and after the fadeout, which may last from a very short time to about an hour.

It has also been observed that the *F*-layer echoes disappear for a longer time than the *E* layer echoes. Since the *D*-layer absorption is common to both echoes, the longer disappearance of *E* echoes must be due to reflection of *E* echoes being very weak. This also supports the view that there is no increase in *E*-layer ionization. It is therefore claimed that the solar eruption of ultraviolet light is absorbed only below the *E* layer. Regarding the intensity of these ultraviolet radiations coming from the sun McNish[2] has pointed out that they may be much more intense than those produced if the sun were a black-body radiator at a temperature between 6000° and 7000° K and that during these chromospheric eruptions, the intensity of emission of the ultra-violet light becomes four to five times higher.

It may be pointed out that about two years ago Prof. M. N. Saha[3] in a discussion put forward the view that the generally accepted idea that the sun radiates like a black-body is absolutely arbitrary and that certain phenomena, as for example the occurrence of N_2^{+} lines in the evening and morning flash (as observed by Slipher), clearly point out that the sun's emission in the ultraviolet is entirely different. His exact words about the emission of the sun in the ultraviolet are :

"It appears probable that if we observe the solar spectrum outside the atmosphere of the earth, it will appear very much like those of *planetary nebulae* composed of faint continuous background superimposed with bright emission lines of H, He, He^+, Fe^+, Fe^{++} and other elements which are abundant in the atmosphere of the sun and which have their resonance lines in this part of the spectrum."

Most of the previous observers have tried to connect the radio fadeouts with the emission of H_α line, but it should be remembered that the H_α-line is only indicative of the condition of general disturbance in the sun. When H_α is found in emission, it must be accompanied and certainly exceeded in intensity by the lines of He, He+, Fe^+, Fe^{++}, etc. The action which is produced in the earth's atmosphere will be due to the combined effect of all these ultraviolet radiation.

There seems to be a tendency to ascribe the formation of extra ions or electrons in the *D*-layer to L_α and L_β lines. As Prof. Saha[4] pointed out, neither L_α nor L_β can directly produce any ionization of the O_2 and N_2 molecules, because the lowest I. P. of O_2 (12.2 e Volts) and N_2 (15.5 e-volts) are larger than the energy contained in L_α (10-15e- Volts) and L_β (12.03 e-Volts). It is only L_γ and other higher members of the Lyman series which can ionize O_2 to O_2^+. In the case of L_γ, there is a certain amount of experimental evidence[5] (though not quite definite) that it is more strongly absorbed by O_2 than other lines of Lyman series. None of these lines L_α, L_β will be able to ionize N_2, they can only excite oxygen and nitrogen molecules to higher excited states of the neutral molecule. Probably when excited by L_α and L_β, O_2 excited may predissociate into atoms but it is not correct to say as Martyn and Munro[6] express in a recent note to *Nature* that such excited atoms in collision with others will produce ionization. A large number of collisions which undoubtedly take place in the *D*-region may give rise to dissociation, but collisions, unless very violent, are not known to produce any ionization. The extreme ultraviolet emission lines of He and He^+, if they are emitted during the solar eruption can on energy considerations ionize N_2 to N_2^+.

All this discussion shows the necessity of (1) obtaining the spectrum of the sun in the ultraviolet from the top of the stratosphere[7] (2) and of carrying out well planned experiments in the region λ2000—λ500 on the photochemical effect of light on O_2 and N_2 as emphasized by Prof. M. N. Saha.

Physics Department,
Allahabad University,
Allahabad.
18. 11. 37

R. N. Rai
K. B. Mathur

1. McNish, *Terr. Mag. 42*, 109, 1937.
Berjner & Wells, *Terr. Mag. 42*, 183. 1937.
Martyn & Munro, *Nature. 140*, 603. 1637.
2. McNish. *loc. cit.*
3. Saha, *Pro. Nat. Ins. Sc. India. 1*, 217, 1935
4. Saha, *loc. cit.*
5. Takamine Suga, *Scie. Papers, Inst. Phys. Research Tokyo*, *640*, 213, 1936.
6. Martyn and Munro *loc, cit.*
7. Saha, *Bull. Harvard Obs. 905*, 1, 1937.

On a Certain Point in the Proof of Kirchoff's Law (A reply)

My note[1] under the above heading has been criticized by Mr Duleh Sinha Kothari[2] in a letter under the title "On the analytical proof of Kirchoff's Law". The point

raised by him are answered below. (1) Kirchoff's Law propounds a certain relation between the emission and absorption coeffecients of a body at any given temperature, whereas the proposition proved in my note was that the emission coeffecient of the wall of uniform temperature enclosure is the same at any point inside it irrespective of the position of the point with respect to the enclosure wall: this indeed is very different form Kirchoff's Law, and it is strange that Mr Kothari, who has quoted my proposition all right, should confuse the same with a statement of Kirchoff's Law, which it was never my intention to prove analytically or otherwise. (2) Mr Kothari is under the impression that the equilibrium condition as postulated in my note, *e.g.*, the 'heat received" by the small accessory sphere is the same for all positions, is wrong. It seems, that having too much concentrated on the term "heat received", he has failed to pay any heed to its mathematical definition, *e.g.*, $\Sigma ds \int_0^\infty a_\lambda e_\lambda \, d\lambda$: now this a_λ refers to the absorption coefficient of a portion of the sphere, and e_λ to the emission coeffecient of the enclosure wall, hence the expression really stands for what Mr Kothari wants to be "heat absorbed". His criticism would perhaps have some justification if for 'heat received' the expression $\Sigma ds \int_0^\infty e_\lambda d\lambda$ (total radiation incident on the sphere) had been substituted for $\Sigma ds \int_0^\infty a_\lambda e_\lambda \, d\lambda$. So his dilatation on the point is quite out of place. (3) Minute points were omitted since they are adequately dealt with in textbooks. However to avoid misunderstanding "heat received" may, if desired, be replaced by "radiation absorbed" and also the chain of arguments may be completed thus: for equilibrium, the enclosure wall and the small sphere eventually attain the same temperature; again, total emission from the sphere depends only on its temperature and not on its position; also, since emission and absorption must balance for the steady state of equilibrium, it follows that the amount of radiation absorbed which is also the amount emitted must be the same for all positions (rotations or translations; in my note only rotation has been considered, since that was sufficient for the purpose).

Indian Association for the
Cultivation of Science,
210, Bowbazar Street,
Calcutta,
11.11.37.

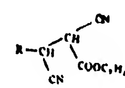
B. Mukhopadhyay.

SCIENCE AND CULTURE, 2, 118, 1937
Ibid. 4, 245, 1937.

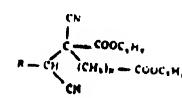
Synthesis of 2—Phenylcyclopentanone—3—carboxylic acid and 2—Phenylcyclohexanone—3—carboxylic acid.

A general scheme for the synthesis of mono, bi, tri, and polynuclear compounds is described in the present communication.

The method consists in condensing the sodium salt of the dicyano ester (I) formed by the condensation of an aldehyde-cyanohydrin with ethyl sodiocyanoacetate with a monohalogenated ester to yield the product (II). This on hydrolysis gives an acid, the triethyl ester (III) of which, when subjected to the Dieckmann condensation, yields the product (IV). The ester (IV) on hydrolysis yields a keto-acid (V). By the Clemmensen reduction of the keto-acid (V) and subsequent ring closure or by effecting the ring closure of the reduction product obtained after Reformatsky's reaction on the ester of the keto acid (V) it will be possible to get other types of ring system.



(I)



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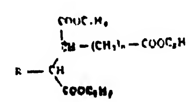

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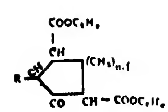

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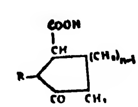

(V)

(*R* is either alkyl or other ring system and *n* may have values ranging from 1 to 3)

For the synthesis of 2-phenylcyclopentanone-3-carboxylic acid the following method has been adopted. Benzaldehyde-cyanohydrin is allowed to react with the sodium salt of ethyl cyanoacetate when the sodium derivative of ethyl-$\alpha\beta$-dicyano-β-phenylpropionate (I, $R=C_6H_5$ m.p. 64° C.) is obtained. It is allowed to react with ethyl β-chloropropionate when diethyl $\alpha\beta$-dicyano-α-phenyl-*n*-butane-$\beta\delta$-dicarbxoylate (II, $R=C_6H_5$, $n=2$ b. p. 218°-22°/5 mm.) is

obtained. When hydrolysed by means of sulphuric acid (70%) the latter yields an acid (m.p. 166°C), the triethyl ester (III, $R=C_6H_5$, $n=2$ b. p. 187°-94°/5 mm.) of which undergoes cyclization in presence of sodium in benzene to yield diethyl-2 phenylcyclopentanone-3, 5,-dicarboxylate (IV, $R=C_6H_5$, $n=2$ b p. 181°-92°/5mm.). Thise ster on hydrolysis yields the required 2-phenylcyclopentanone-3-carboxylic acid (V, $R=C_6H_5$, $n=2$ m p. 114°-15°C). Semicarbazone of the ethyl ester (m.p. 173°C)

Similary 2 phenylcyclohexanone 3 carboxylic acid (V, $R=C_6H_5$, $n=3$) has been obtained from benzaldehyde-cyanohydrin and ethyl γ-bromobutyrate.

Investigations are in progress with other ring systems.

In conclusion, the author's respectful thanks are due to Professors Sir P. C Ray and Dr P. C. Mitter for their kind interests in the work. The author is indebted to Mr S. Saha for microanalysis.

Sir P. C. Ray Fellow's Laboratory,
University College of Science and Technology,
Calcutta.
17.11.37 Nripendra Nath Chatterjee.

A Query on the Cuddapahs of Peninsular India

According to Dr A. M. Heron of the Geological Survey of India, the Delhis of Rajputana are highly disturbed and metamorphosed forms of the Cuddapahs. This finds a support in the gradual increase of deformation and metamorphism noticed in certain Cuddapahs rocks of the Central Provinces. The stages of evolution are indicated by the following :—

(1) The south eastern boundary of the large exposure of the Cuddapahs mapped by H. Crookshank in the Baster State "is a straight line, and therefore, probably a fault". The western boundary is irregular and is therefore said to approximate to a boundary of deposition.[1]

(2) The small exposures of the Cuddapahs newly discovered by Dr P. K. Ghosh in the Baster State "forming as they do but a thin covering on the underlying Archaeans, while generally sharing in these vertical movements, show in places, particularly near the marginal regions of the basins, the usual signs of disturbances produced by lateral compression, *viz.*, folding, crumpling and schistosity".[2]

(3) As regards the Cuddapahs (previously believed to be Vindhyans) of Chhattisgarh, H. B. Medlicott, W. King, and P. N. Bose record innumerable signs of great disturbance within and around this vast exposure. The disturbance has been so great that the relation between these rocks and the associated Chilpi beds (Archaean) is up till now an unsettled problem as indicated by the following :—

"The relation between the Chilpi series and the proper Chhattisgarh Vindhyans must therefore still remain an" open question and though I have tried as well as I could to put forward some of the points which strike me as not satisfying the requirements of Mr Medlicott's suggestion, it will be safer to hold by it until better evidence can be accumulated".[3]

These remarks by King also suggest that a proper study of the exposure of the Chhattisgarh Cuddapahs (or Vindhyans) alone is likely to show quite a large number of the various stages of evolution of highly schistose Cuddapahs from unmetamorphosed varieties.

The recognition of this gradual transformation of unmetamorphosed Cuddapahs (in Mr Crookshank's area) to their highly metamorphosed representatives (in Rajputana) leaves one to wonder about Sir Lewis Fermor's contention to include the Delhis among the 'Ancient Schistose Formation of Peninsular India', just to maintain 'consistency'[4]

The various degrees of alteration that the Cuddapahs of the Central Provinces and Rajputana have suffered, raise two difficult questions :

(1) How to distinguish between the Delhis and other metamorphic equivalents of the Cuddapahs from the Cuddapahs proper ?

(2) How to distinguish between the metamorphic facies of the Cuddapahs (like the Delhis) from that portion of the 'Ancient Schistose Formation of India' which is equivalent to the Delhis according to Sir Lewis' classification ?

Again, the deformation of the margins of the Cuddapahs is likely to involve portions of the rocks adjacent to them. When the Cuddapahs or the adjacent rocks are very soft or brittle deformation is very likely to cause intimate intermixtures. How are the true Cuddapahs to be distinguished from their crushed associates in such instances ? And what will be the nature of the boundary which is likely to develop the Cuddapahs and their associates ?

The Geological Survey of India is engaged in mapping numerous exposures of Cuddapahs in the Central Provinces and have placed the Indian Geologists in general under a deep debt of gratitude for some of the maps of these areas mapped with sedulous care. Will the Geological Survey of India add to their kindness by coming forward with their views regarding the solution of the questions raised ?

3C, Jainuddi Mistri Lane,
Alipore, Calcutta. D. N. Mukherji
13.11.37

1. *Rec. G. S. I.*, *71*, Part I, p. 87.
2. *Rec. G. S. I.*, *71*, Part I, p. 89.
3. W. King, *Rec. G. S. I. 18*, Part 4.
4. *Mem. G. S. I. 70*, Part I, p. 5.

Sir Jagadis Chunder Bose

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Obituary

SIR JAGADISH CHANDRA BOSE

We mourn, with the whole of India and the entire scientific world, the loss of Sir Jagadish Chandra Bose, who died on the 23rd November last at the age of 79. The eminence Sir Jagadish Chandra attained as a scientist is well known. He was one of those few distinguished Indians who bore the torch of knowledge wherever they went, and won for India and her culture and tradition high esteem from all parts of the world. We publish below an account of the life and work of Sir Jagadish Chandra, written by one who was in close contact with him for a long time.

— *Editor,* SCIENCE & CULTURE.

Early Life and Education

Sir Jagadish Chandra Bose was born on the 30th November, 1858, in the village of Rarikhal in Bikrampur. His early days were spent in Faridpur, where his father Bhagawan Chandra Bose was posted as a Deputy Collector. The latter was a man of broad sympathies and of generous impulses, who ruined himself by his attempts to establish swadeshi industries. Bose was fortunate in having such a wise and sympathetic father to guide him through his youth. His school education was completed in the St. Xavier's School; he also graduated from the same college and it was the influence of Father Lafont which aroused his interest in experimental physics. Like the latter, Bose developed later a flair for experimental demonstration which has kept many audiences in rapt attention. When it was decided to send him to England, it was his mother who sold her jewels to find money for her son's education. Owing to his father's objection to I.C.S., Bose decided to study medicine in London. But after repeated attacks of malarial fever contracted in Assam prior to his departure for England, Bose had to give up the study of Medicine and take up Natural Science. He joined the Christ's College in Cambridge, and later took his degree both in Cambridge and in London, with physics, chemistry and botany. He had for his teachers Rayleigh, Livieng, Michael Foster, Francis Darwin, Dewar and Vines. They all remembered and helped him in many ways when Bose later returned to England to demonstrate the results of his investigations.

Appointed Professor of Physics

On his return to India, and on the recommendation of Lord Ripon, he was given a professorship in physics in the Presidency College, Calcutta, in 1885. Being an Indian he was entitled to two-thirds salary and as the post was an officiating one, only half of that was offered to him. He protested against this invidious distinction, and for three years, refused to accept the cheques by which he was paid his salary. He married in 1887 the second daughter of Mr. Durgamohan Das, and the golden anniversary of their wedding was celebrated on the 27th January, 1937. Owing to the great financial difficulties under which the newly married couple started their life, they had to take a house in Chandernagore on the bank of the river, from where he used to cross over everyday to Naihati in a rowing boat, which used to be taken back by his wife. Later in the early nineties he came down to Calcutta and shared a house with a large compound in Mechuabazar Street with his brother-in-law, Dr M. M. Bose. At this period he was engaged in various scientific hobbies including photography and sound recording. One of the earliest models of Edison's phonograph was purchased by the College, and Bose was engaged in experiments in voice-recording and reproduction. His work in photography was taken up very seriously. In the lawn of his house a studio was erected and equipped. He used to go out on photographic excursions during the vacations. In the midst of all these scientific recreations he had kept up his interests in Hertz's experiments with electro-magnetic waves, which had caused a great amount of interest in scientific circles while he was in England. On his thirty-fifth birthday in November 1893 he decided seriously to devote himself to the pursuit of new knowledge and from the following year he began to publish his series of investigations on the properties of electric waves.

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Bose's Contributions to Physics

Bose's researches fall under three main groups. In the first period he deals with the properties of electric waves, in the second period with the study of the similarity in behaviour under the action of electric waves of a class of substances used for detecting such waves to that shown by living tissues. Thus he was led to the investigation of the responses in the living and the non-living. From such studies he was finally led to investigate the physiological properties of plant tissues and to demonstrate the similarity of their behaviour to that of animal tissues.

In course of his electric wave investigations, he devised an extremely compact form of generator of electromagnetic waves, in which the radiating source was a sparking system between platinized spheres, which emitted radiation of wavelength of about 5 mm., which is about the limit of the shortest electromagnetic waves which have so far been investigated. For his detecting system he used an improved form of coherer, which had been first used by Branly of Paris. The detailed study of the action of the coherer proved later on to be the turning point in Bose's career. The form of coherer first used by him consisted of a number of fine wire spiral springs, adjusted with a large number of regular contacts fixed in ebonite and under the control of a spring. A weak current flows through this, to which the spirals offer appreciable resistance. On the impact of electric radiation, this resistance is appreciably diminished resulting in a large deflection in a galvanometer which is used in the circuit as an indicating instrument. In the early forms of the coherer it was necessary to tap the latter in order to bring it back to its initial condition of high resistance. Bose later on devised other forms of coherer which showed the property of automatic recovery. The apparatus thus built up was not only very sensitive and regular in behaviour, but also very neat and compact; it could be packed up in a small suit-case and put up on the end of a writing table. Compared to the large wavelength of the radiation used by Hertz and Lodge, which required the use of optical apparatus of enormous dimensions, and which gave rise to uncontrollable stray radiations by diffraction effects, Bose's small and compact apparatus at once attracted the appreciative attention of the leading European physicists, and its description appeared in text-books by Poincare, in an *Encyclopedia Britannica* article by Sir J. J. Thomson, and in other text-books. With this apparatus Bose was able to demonstrate the optical properties of reflection, refraction, selective absorption, interference, double refraction and polarization, rotation of the plane of polarization, etc. It was found that a crystal named Nemalite produced polarized electric waves by selective absorption in the same way as Tourmaline does for visible light waves. Since the electric waves due to the comparatively large wavelengths were not much absorbed by air and other media, Bose investigated the possibility of sending electric signals through long distances, and in a lecture experiment showed the possibility of sending signals over a distance of 75 feet with three solid walls intervening. Those who visited Bose in his house in Convent Road at this time could have seen him working with his apparatus for sending and receiving signals in the shape of the ringing of bells. In this apparatus flat metal discs on the top of long rods were used for facilitating the sending and receiving of signals, anticipating in some ways the use of antennae in radio-telegraphy. The possibility of practical application of this method of sending signals did not escape the attention of interested people, when Bose in 1895 went to England and demonstrated to various learned societies the results obtained by the apparatus constructed by him. If one takes into consideration the very limited workshop facilities available in the Presidency College Laboratory in those days, one can well understand the chorus of appreciation with which distinguished physicists in Europe like Kelvin, Rayleigh, Thomson, Lippman, Cornu, Poincare, Warburg, Quincke, and others received this demonstration.

Investigation of the Response in the Non-living

We come now to the second period of his physical researches, which led to his postulation of the similarity in the response in the living and in the non-living.

In course of investigating the suitability of different materials as coherer, he found that in certain class of substances the incidence of electric waves lead to a diminution of contact resistances, while in another class of substances of which potassium and arsenic are representatives, an increase in electric resistance under radiation was observed. For this type of effect

he introduced the word Electric Touch or Contact Sensitiveness in preference to the word then used 'Coherence'. He further noticed that this contact sensitiveness diminished with constant impact of radiation and it recovered its previous sensitiveness if the receiver was laid aside for a long time. In fact all the characteristics of the behaviour of a living tissue under stimulation was exhibited. In the course of his investigations he, about the same time with Shelford Bidwell, investigated the change of conductivity of Selenium cell under the action of light. The work of these two pioneers in this field is mentioned in a report which appeared recently in Physikalische Zeitschrift of the rapidly growing and technically important subject of photo-conductivity and contact rectification in semi conductors. At the time of Bose's investigation, the electron had just been discovered in the phenomena of gaseous discharge, but its application to the conductance in solid had not been considered and Planck's Quantum theory of Radiation was just being formulated. To explain the variation in response of material bodies under different types of stimulation, Bose postulated his molecular stress and strain theory, *viz.*, every type of stimulus, be it electrical, mechanical, effect of radiation visible or invisible, produces a state of molecular strain in the substance, and one of the most delicate method of investigating this state is by means of electrical conductivity measurements. If left to itself the substance returns from its strained state and behaves normally again. The electric behaviour of a large class of substances under different types of stimuli was investigated and interpreted under the molecular stress and strain theory. One of the most successful applications of this was in explaining the disappearance of the latent image in an exposed photographic plate, if it is not developed within a certain time. All these effects find an explanation in Pohl's investigation of photo-conduction and light absorption in alkali- and silver-halide crystals and its interpretation in terms of Franck's theory of photosensitized activity. Another interesting application of Bose's theory was the interpretation of binocular alteration of vision. A physicist cannot help regretting that Bose should have left this promising and the then unexplored region of physical investigations in which he could have been a pioneer, for physico-physiological investigations, where his appearance was resented by the orthodox physiologists, and his work was much hampered due to this opposition.

Work in Plant Physiology

In 1900, Bose attended the International Congress of Physics in Paris, and read a paper on the generality of molecular phenomena produced electrically in living and non-living matter in which he brings together a large amount of comparative observations on the similarity of responses in the two classes of substances. It is interesting to note that he used the ferromagnetic magnetite as specimen of non-living matter: It was shown in this and subsequent papers that many of the effects of stimulation shown by living tissues were also shown by non living matter, thereby extending the degree of similarity in behaviour in living and non-living matter. In England Bose's communications of his investigations had a mixed reception, some of the physiologists headed by the veteran Sir John Burdon Sanderson were opposed to the interpretation of the results of his experiments. As a consequence, his communication to the Royal Society was only read but not published and placed in the archives of the Society. It was at this juncture that some of the leading botanists who were office bearers of the Linnean Society, including Vines, Howes and Horace Brown, and who had seen his experiments, offered the hospitality of the Society for the reading and publication of his paper. In the course of these investiations, Bose became more and more interested in the response of plant tissues under different kinds of stimulation, and of their similarity to that shown by animal tissues. Now began the third epoch of his investigations on plant response, which were communicated in a series of papers to the Royal Society in 1903, and it was proposed to publish them in the *Philosophical Transactions.* As he was now away from England, the opposition group was successful in holding up his papers on the ground that his results were so unexpected and so opposed to current theories that nothing short of the plants automatic record would carry conviction. In the early days when the investigations on the plants were commenced the response in plants were magnified by optical levers, which was first introduced by him in plant physiology, and recorded by following the movement of the spot of light on a drum with a pencil. This rebuff from the Royal Society spurred Bose to devise more and more sensitive

apparatus for making the plant to write down its own autograph. Bose's permanent contribution to the experimental plant physiology is the series of instruments devised and manufacturd in the workshop of his Institute, like the Resonant Recorder, the high magnification Crescograph, the Photosynthetic Recorder etc. Bose was constantly changing and improving his apparatuses and his biographer Geddes humorously remarks at one place

"The one criticism of the apparatus and research in the Institute which the writer has ventured to make from time to time is, that one might sometimes be fruitfully enough engaged with this or that instrument without the delay of demolishing and reconstructing it for the sake of some after all minute percentage of extra exactitude. Yet he cannot but respect this also, and bear his testimony to the physicists' precision, which can endure no trace of inaccuracy."

It is generally assumed that there are certain fundamental resemblances in the behaviour of all living cells in virtue of their possessing the same ground plan of protoplasmic structure. The fundamental properties of the protoplasm are contractility, conductivity, rhythmicity. In animal organisms these functions are taken up by specialized tissues such as muscles, nerves and organs composed of nerves and muscles. Bose's great problem was to discover similar functions in plant tissues.

The contractility in plant is demonstrated by his diametral contraction apparatus. He showed that plant tissues undergo change in shape under the action of electric stimulus as animal muscles do. By means of resonant recorder, which can measure intervals up to one thousandth of a second, he demonstrated that the conduction of impulses in the plant tissue follows the same laws as in the animal tissues, the effect of the application of warmth, cold, depressant and exciting drugs and of homodromous and heterodromous electric currents producing identical effects. These experiments definitely opposed the then accepted theory of the hydraulic transmission of impulses in plants.

By means of his oscillating recorder he showed that the rhythmic pulsation of the leaflets of Desmodium and of other plants are of the same category as the pulsatile activity of an animal heart. He demonstrated, that the source of pulsatile movements in Desmodium leaflets is light stimulus, the response being proportional to the quantity of light falling on the leaflets—light impulse of a short duration producing a single pulsation whereas stronger light or longer exposure producing multiple responses.

Another outstanding problem of plant physiology is the movement of sap in plants. The generally accepted view at his time being that the movement is due to the action of purely physical forces such as capillarity, osmosis, transpiration and of a new type of force root pressure. Bose, on the other hand, while not denying that these forces may be partially effective in causing sap movements, maintained that the principal factor was a vital phenomenon probably of a pulsatile character. He used to show a simple experiment where two wilted leaves one dead and one living, coated with vaseline to prevent transpiration and detached from the parent plant to prevent the action of root pressure, showed very different activities, when their stems are put in tepid water, the living one becoming erect in a very short time, while the dead one not responding at all. He devised some very ingenious experiments to explain this pulsating activity of the plant cells when transmitting sap through the tissues. Other important problems dealt by him were the investigation of tropic movements in plants. His main hypothesis in explaining the opposite activity of different parts of plant tissues to the action of a stimulating agent like gravity and light, was that a stimulus of the same kind produced opposite effect in a given tissue, depending upon its intensity, weak stimulus producing positive and strong stimulus negative effect.

The Bose Research Institute

While in the midst of these investigations, Bose's period of service in the Presidency College was nearing its end and he had to retire in 1915 after he had completed his fifty seventh year of age. He was still active and vigorous and he felt the need of continuing the researches he had so well begun. For two years he continued his work partly in a laboratory fitted up in his own house in Upper Circular Road and partly in Darjeeling. He felt that the time had come for establishing a research institute where his work in Bio-physics could be carried on by a band of research scholars. For a long time he had cherished the idea of starting a research

institute of his own and was saving money for the purpose. As he was nearing the end of his period of service, it was discovered by the Government that though by his seniority he was entitled to the highest grade in the Education Service, his claims had been overlooked. He was gazetted to the highest grade with retrospective effect. The large amount received as back pay was credited to the account of the prospective Research Institute. Also a legacy from an old, valued friend was received for this purpose. All these amounts were very carefully invested and had increased considerably by the time the Institute was started. To this was added some donation received from the public and an annual subvention from the Government. A plot of land to the north of his house was purchased and a beautiful well-planned research institute was built and opened on 30th Nov. 1917.

The results of the investigations carried out in the Institute were published in the *Transactions* of the Bose Institute which first appeared in 1918. From time to time he summarized the results of these investigations in monographs, the last of which, entitled '*Growth and Tropic Movements in Plants*,' appeared in 1929. As a member of the Committee for Intellectual Co-operation of the League of Nations, he used to visit Europe every summer for five years and come in contact with the leading intellectuals of the Western World. In 1928 he visited some of the leading University centres in Europe where his lectures and demonstrations aroused a great deal of interest. Prof. Moölisch of Vienna (who died very recently) accompanied him to work in his Institute for six months. At the time of leaving the Institute he wrote a letter to the *Nature* (April 13, 1930) testifying to the remarkable experimental work which was being carried out in the Institute. "I saw the plant writing down the rate of assimilation of its gaseous food. I also observed the speed of the impulse of excitation in the plant being recorded by the Resonant Recorder which automatically records intervals of time as short as thousandth part of a second. All these are more wonderful than fairy-tales; nevertheless those who have the opportunity of seeing the experiments become fully convinced that they are laboratory miracles revealing the hitherto invisible reactions underlying life."

The Seventieth Birthday

The seventieth birthday of the founder of the Institute was celebrated with great solemnity on 30th Nov. 1928, when Bose received congratulatory addresses from many learned bodies. With increasing age and growing infirmity, Bose gradually withdrew from the active guidance of research and confined himself more to a critical supervision of the work of the scholars. He also interested himself in providing facilities for research to promising independent workers in different subjects like theoretical physics, investigation of cosmic rays, plant genetics and anthropology. Bose's great contribution to the study of plant physiology has been first the incomparable set of apparatus devised by him, his bold hypothesis of the similarity of reaction and of mechanism in plant and animal organism, and his attempt to isolate these in the case of plants. Many valuable results have been established but it cannot be said that the problems have received their final solution. Research fellowships and post graduate scholarships are being endowed by the money left by him for the study of plant physiology and allied subjects. It is to be hoped that this band of scholars in co-operation with the workers of the Bose Institute will begin with new enthusiasm the study of this vastly interesting subject of biophysics. New methods of investigation employing heavy water and radioactive isotopes of common elements assimilated by living organisms are being uti-

Sir J. C. Bose with some of his past students, taken on the occasion of his 70th birthday anniversary.

Standing from left to right: Dr S. Datta, Prof. S. N. Bose, Prof. D. M. Bose, Prof. N. R. Sen, Prof. J. N. Mukherjee, Prof. N. C. Nag.

Sitting: Prof. M. N. Saha, Sir J. C. Bose, Prof. J. C. Ghosh.

lized by workers in Bohr's laboratory in Copenhagen and elsewhere for investigation of the problem of assimilation. Workers in the Institute will no doubt utilize these methods along with those already in use there.

Other Activities in his Life

No account of Bose's life will be complete which deals only with his scientific activities. He was a man with many sided interests and activities. In the early nineties he used to spend his vacations armed with a full sized camera photographing sites of ancient Indian monuments and of scenic beauty. Unfortunately his beautiful collection of negatives were destroyed by the misguided activity of a laboratory menial. His Bengali prose writing has been declared by competent critics to be of high literary value, and sure of a permanent place in Bengali literature. His friendship with Rabindranath Tagore is well known, the latter was one of the first to recognize the importance of Bose's achievements, and the story of how he helped Bose in his period of difficulties is told in the current number of the *Prabasi*. The new school of Bengali artists found an appreciative friend and helper in Bose. Paintings of Gaganendra nath Tagore, Abanindra nath Tagore and Nanda lal Bose are to be found in his house and on the walls of the Institute building. The latter is a beautiful adaptation of ancient Indian architecture to modern requirements, and was erected under his direction by his cousin, Abaninath Mitter. His early biological training and his inheritance of the pantheistic outlook of ancient Indian culture penetrated deeply into his scientific thought. He is the first Indian scientist of emience who has tried to align his scientific investigations to the traditional pantheistic view of Nature prevalent in this country. Future historians of science may find the introduction of this standpoint an important contribution of the Indian mind to the scientific conception of Nature. In a letter written after receiving the news of the death of Sir J. C. Bose, Sir Michael Sadler remarks that " He was a poet among biologists. Shelley, had he gone on with Science, and had he lived in days of exact measurements, might have shared in his (Bose's) work."

D.

An Appreciation of the late Sir J. C. Bose

Sir Jagadish Chandra Bose, F. R. S., the great Indian scientist and patriot, is no more. With his passing at the age of nearly eighty years is removed one of the few links that remained between the present dynamic period of Indian science and those dark centuries which had so long separated us from a proud antiquity.

It was my good fortune to have known Sir Jagadish, though not intimately, since the year 1915 when I had just begun my career as a research student at Cambridge. He was then making one of his many scientific tours abroad. There were no real points of contact between our spheres of work, which were perhaps as far apart as any two branches of botany very well could be. But I am one of those many countrymen of his who are grateful to him for creating in India a background of scientific research in which we who came after him felt encouraged in our efforts. It is with feeling of gratitude that I wish to pay my homage to the departed leader.

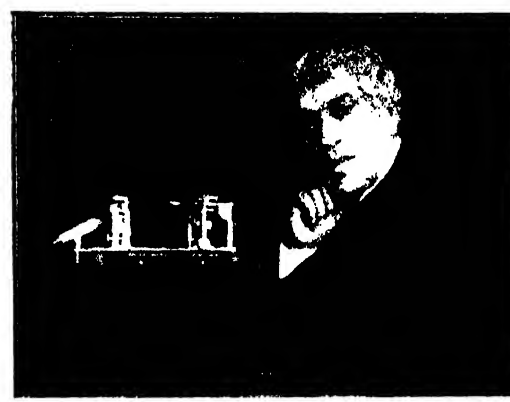
The only fair estimate of a man comes from an appreciation of the setting in which he lived and moved. In any age and in any country J. C. Bose would have been distinguished for his originality and his skill as an investigator. Viewed in his own setting of time and place, he appeared as an unexpected light on a dark horizon. He began making original contributions to experimental science at a time when no one from this country had yet ventured into that field. Currency was being given to the belief that the Indian mind was traditionally unfitted for grappling with the science of the concrete. It is therefore no wonder that Bose's early researches, of which the merit was at once acknowledged by Western physicists, created something like a sensation in scientific circles. It was natural, too, that this lead should have come from Bengal, the province which had led the way for northern India in matters educational, as it has done since in other directions. And Bose possessed all the attributes of the pioneer: an intensely imaginative personality, an almost child like curiosity about the unknown, which he preserved to the end, indomitable courage in the face of obstacles and, above all, a burning zeal, bordering upon the fanatic, for raising his country in the eyes of the scientific world.

OBITUARY

A botanist like the present writer, who has been chiefly concerned with the investigation of fossils, will hardly be expected to comment upon the technical aspects of Sir J. C. Bose's many important discoveries. These lay in the field of experimental science, at first in physics, then in plant physiology. But we all know that in both these spheres he had achieved remarkable success, for he was a past master in manipulative skill and in the invention of sensitive devices for recording the subtle responses of living and non-living objects. The significance of his early work in connexion with the discovery of wireless means of communication is universally acknowledged, although he unfortunately did not pursue his quest far enough to reap the full fruits of his researches in that line. Like most other scientists who have dedicated their lives to the acquisition of knowledge for its own sake, he spurned the idea of commercializing his discoveries.

Sir J. C. Bose's investigations in the field of protoplasmic response in plants, to which he devoted the greater part of his long and distinguished career, have been the subject of much controversy. But if justice must be done, it is important to keep two aspects of this work distinctly apart. One aspect is that of the purely experimental observations, covering a period of many years of intense application in the laboratory and recorded in numerous papers by Sir Jagadis himself, and more recently by his pupils. In much of this laborious work he was ably assisted by his devoted pupil Bosheshwar Sen, who accompanied him on many of his scientific tours and upon whom devolved the success of the demonstrations, given before many distinguished gatherings in Europe and America. Some of these observations, which were at first received with scepticism, were later confirmed by eminent plant physiologists, among them Professor Hans Molisch of Vienna. Molisch paid a visit to Sir J. C. Bose in Calcutta in the year 1928 and paid a high tribute to his originality and experimental skill.

The other aspect of Bose's work is the theoretical aspect, embodying his deductions from the experimental data. Some of these deductions have been severely criticized. But this, it must be borne in mind, has been the fate of many other original theories which, unlike the observed facts upon which they are based, are often more or less influenced by the personal factor. Healthy criticism is like a fertilizer upon which the sapling of original research thrives. But it is an open secret that much of the criticism which Sir J. C. Bose had to face came from quarters incapable of forming an unbiased judgment. Happily, Science has its impartial tribunals: the Royal Society did not fail to accord to Sir J. C. Bose the recognition that had so long been his due, and he was honoured by many other Learned Societies, by Universities and by distinguished men all over the world. Long after the dust of personal controversy is laid, the mass of careful and detailed observations which Bose had accumulated during many years of labour will stand as a solid basis for future research. Whether the theoretical frame-work which he had built upon it will endure the test of time— and all scientific theories are subject to that test— he will be remembered as the leader among those who helped modern India to her feet in the world of science.



Sir J C. Bose

The foundation of that Research Institute in Calcutta with which Sir J. C. Bose's name will for ever be associated, is visible testimony of his foresight and of the high appreciation with which his services to science were regarded by those who were in a position to finance him. But more abiding and more significant for the future was the spirit that Sir J. C. Bose infused into successive generations of students, so many of whom now occupy prominent positions in the intellectual life of the country.

Bose's name will not only endure in the annals of original research: he will also be remembered as a pioneer in creating public opinion in favour of Indian students engaging in scientific activities. With his flair for popularizing science in India he

was prone to employ a figurative mode of expression which, perhaps somewhat naturally, evoked comment in scientific circles. But here again we must take into account the fact that he was addressing mixed gatherings, often of a size unequalled except on the political platform, and that the great majority of those who heard him were unaccustomed to see the hard, concrete facts of science except in a highly metaphysical and philosophical light. The essential unity of plant and animal life was with him, as with many others brought up in the Indian tradition, a matter of spiritual conviction. But as a modern scientist he was out to demonstrate this elementary truth in all its manifold aspects to the man in the street. This was by no means an easy task, but with the painstaking effort which he always devoted to his lectures and demonstrations he achieved a remarkable measure of success. At the same time it is not inconceivable that when he turned to apply his extraordinary powers of exposition of inanimate phenomena to the investigation of life processes in plants he sensed a closer analogy with the nervous mechanism in animals than most of us are prepared to agree. In other words it is possible that he was well ahead of the times and that his work foreshadows the fertile impact of a traditionally sensitive philosophical mind upon the still almost hopelessly mysterious phenomena of life. Whether this was really the case the future alone will show. For the present let us be grateful for the past that has brought us to the threshold of that future.

Birbal Sahni

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The Indian Science Congress

—Message from Pandit Jawaharlal Nehru

Most of us unhappily are too much engrossed in the business of politics to pay much attention to the finer and more important aspects of life. That is natural perhaps in a nation which struggles for national freedom and to rid itself of the bonds that prevent normal growth. Like a person in the grip of a disease, it can think only of how to gain health again, and this obsession is a barrier to the growth of culture and science. We are entangled in our innumerable problems; we are oppressed by the appalling poverty of our people. But if we had a true standard of values we would realize that the Silver Jubilee of the Indian Science Congress this year is an event of outstanding importance. For that Congress represents science, and science is the spirit of the age and the dominating factor of the modern world. Even more than the present, the future belongs to science and to those who make friends with science and seek its help for the advancement of humanity.

On this occasion of the Silver Jubilee, I should like to send my greetings to the Indian Science Congress and to the many distinguished scientists, our own countrymen and our visitors from abroad, who are assembling in Calcutta. He who was chosen to preside over this Congress Session had to end his life's journey before he could come here, but that life itself of distinguished service in the cause of science and great achievement has a message for all of us. Though Lord Rutherford is not here, his written word has come to us and, through the courtesy of the editor, I have been able to glance through his presidential address.*

Though I have long been a slave driven in the chariot of Indian politics, with little leisure for other thoughts, my mind has often wandered to the days when as a student I haunted the laboratories of that home of science, Cambridge. And though circumstances made me part company with science, my thoughts turned to it with longing. In later years, through devious processes, I arrived again at science, when I realized that science was not only a pleasant diversion and abstraction, but was of the very texture of life, without which our modern world would vanish away. Politics led me to economics and this led me inevitably to science and the scientific approach to all our problems and to life itself. It was science alone that could solve these problems of hunger and poverty, of insanitation and illiteracy, of superstition and deadening custom and tradition, of vast resources running to waste, of a rich country inhabited by starving people.

* Lord Rutherford's Address appears elsewhere in this issue.

I have read therefore with interest and appreciation Lord Rutherford's remarks on the role of science in national life and the need of training and maintaining research workers. And then I wondered how far all this was possible under our present scheme of things. Something could be done no doubt even now, but how little that is to what might and should be done. Lord Rutherford tells us of the need for national planning. I believe that without such planning little that is worthwhile can be done. But can this be done under present conditions, both political and social? At every step vested interests prevent planning and ordered development and all our energy and enthusiasm is wasted because of this obstruction. Can we plan on a limited scale for limited objectives? We may do so in some measure, but immediately we come up against new problems and our plans go awry. Life is one organic whole and it cannot be separated into watertight compartments. The Mississipi Valley Committee, writing in their Letter of Transmittal to the Federal Administration of Public Works U.S.A., refer to this planning business: "Planning for the use and control of water is planning for most of the basic functions of the life of a Nation. We cannot plan for water unless we also reconsider the relevant problems of the land. We cannot plan for water and land unless we plan for the whole people. It is of little use to control rivers unless we also master the conditions which make for the security and freedom of human life."

And so we are driven to think of these basic conditions of human life, of the social system, the economic structure. If science is the dominating factor in modern life, then the social system and economic structure must fit in with science or it is doomed. Only then can we plan effectively and extensively. Lord Rutherford tells us of the need for cooperation between the scientist and the industrialist. That need is obvious. So also is the need for cooperation between the scientist and the politician.

I am entirely in favour of a State organization of research. I would also like the State to send out promising Indian students in large numbers to foreign countries for scientific and technical training. For we have to build India on a scientific foundation, to develop her industries, to change the feudal character of her land system and bring her agriculture in line with modern methods, to develop the social services which she lacks so utterly to-day, and to do so many other things that shout out to be done. For all this we require a trained personnel.

I should like our central and provincial governments to have expert boards to investigate our problems and suggest solutions. A politician dislikes and sometimes suspects the scientist and expert. But without that expert's aid that politician can achieve little.

And so I hope with Lord Rutherford "that in the days to come India will again become the home of science, not only as a form of intellectual activity but also a means of furthering the progress of her peoples."

Jawaharlal Nehru.

Biology of Longevity and Death*

B. N. Singh

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LONGEVITY and death are the two fundamental characteristics of life, about which biological thought centres and presumably no subject has evoked such widespread and deepseated interest in mankind as the desire to combat old age and overcome death. The enormous disparity in the life duration of organisms is a matter of common knowledge. Life may exist in different forms and sizes and from the tiniest period of a few minutes to several hundred years in the case of plants. It is also known that the organism exists in the form of individuals of various kinds and dimensions and that it often starts with a fraction of the size which it finally attains at maturity. Making use of various unorganized materials as food, it accomplishes a series of chemical, physical and physiological transformations within itself, the net result of which is growth and differentiation. Subsequent to its reaching a size limit characteristic of that class of organisms, the individual gives rise to one or more organisms like the parent and repeats the cycle of growth and development.

These phases of its ontogeny are marked by definite changes in form and function, which bring about a gradual deterioration in its working machinery, such that the loss incurred by continuous reproduction and multiplication is not made good by the process of growth and repair and the organism shows symptoms of senescence or the act of getting old. Senescence in its extreme form expresses itself in absolute cessation of life activities, popularly known as "death". However, the culmination of senescence or death is a phenomenon overtaking only the somatic portion of the organic individual, for before the individual body perishes, a new organism will have been ushered into existence through the reproductive process, thus exhibiting continuity of life in another body. In this sense rejuvenescence is as normal a feature of the organic life cycle as senescence.

The disparity in the life duration and the occurrence of senescence in the organic world raises a number of questions of great interest and importance. Is the variation in the life duration of organisms, a predetermined factor in life or related to metabolic activity or does it arise from the environment? What is the cause of *natural death* as we understand it in the sense of individual bodily deterioration? What are the factors governing senescence and rejuvenescence? And is it possible to eschew or at any rate control senescence?

The problem of longevity and death has been discussed many times in the history of biology, and many hypotheses as to its nature have been elaborated. The works of Robertson[1], Child[2], Loeb[3], Pearl[4] and Metchnikoff[5] enjoy the reputation of standard references on the subject. But the greater part of the work has dealt chiefly with animals and systematic researches on the metabolic aspect of age changes with reference to plants are lacking.

Before we may profitably analyse the duration of life and the causes of old age, it would be necessary to gain an insight into the nature of

* Summarized results of author's experimental studies into the physiology and chemistry of plant material covering a period of 12 years.

1. Robertson, T. B. *The chemical basis of growth and senescence*, Phil. and Lond., Lippincott., 1924.
2. Child, C. M.—*Senescence and Rejuvenescence*, Chicago, Univ. Press. 1915.
3. Loeb, J—*Regeneration from a Physico-Chemical view point*, N. Y. Lippincott, 1924.
4. Pearl, R.—*The Biology of Death*, Phil. and Lond., Lippincott, 1923.
5. Metchnikoff—*The nature of Man*, N. Y., 1930. *The Prolongation of life* N. Y., 1910.

growth which is so fundamentally connected with the duration: for just as a reaction in a system cannot be considered independent of the time taken by it for completion, the growth in an organism, like-wise, has to be viewed in relation to the specific time it requires for completing its growth cycle.

Growth involves the synthesis of a variety of chemical compounds in due proportion and succession to one another. This process obviously does not take place with uniform velocity throughout life. On the contrary alternate periods of rapid and slow growth are exhibited. The time-growth curves of plants[6] (plotting increase in dry weight against age) are S-shaped resembling the curves of the autocatalytic reaction in the realm of the non-living on the one hand, and the growth curves of animals on the other. This indicates greater rapidity of growth intially and a marked decline towards the end to be ultimately followed by complete cessation of growth.

The relative-growth-rates[6], when plotted against time show a similar initial increase, leading sooner or later according to the duration of the vegetative period, to a maximum which is followed by a steep fall about the flowering period, eventually reaching the zero line. This is remarkable, for at the start, the cells are young and very little differentiated whereas with the progress of the life-cycle they become increasingly differentiated and would therefore be expected to show progressive growth-rate. About the time of the initiation of the reproductive phase there is a maximum increase in the relative-growth-rate soon followed by a decrease, which succession is thought to be of profound physiological significance since all the external factors are kept above the limiting value. The solution of the phenomenon therefore has to be sought in some internal factor.

The search for this internal factor raises a number of questions. Has the attainment of the maximal growth-rate anything to do with the production of reproductive organs? If so, why should there by a subsequent decline? Are the *ontogenetic drifts* in the relative-growth-rate due to the decrease in growth capacity with increasing bulk of differentiating cells?

On further analysis of growth in two varieties of cotton[7] sown in several series in different seasons, it is observed that in spite of seasonal variations the gradient of the march of growth remains identical in all the series though growth variations in the different series are noticeable in the shape of variations in the final dry weights in the corresponding periods of the age-cycle, in the number of times the reproductive primordia appear preceded by the " maximal humps " in growth-rates, in the period of approach of senility and the final cessation of growth.

Since no differences are perceptible in the form of growth curves of the different seasons, the conclusion is obvious, that the growth variability described above is the product of the environmental effects at the time of sowing and at the earliest seedling stage. The cause for later growth drifts and the initiation of the reproductive phase must therefore be sought in the nature of the early *growth potential* as it obtains at the germination stage in response to the conditioning factors.

The " maximal humps " observed previous to the appearance of reproductive primordia, seem to be associated with a physiological retardation of the growth activity with each initiation of the reproductive phase, and a diversion of the plastic material to the reproductive region.

The relative growth-rates, the assimilatory and respiratory indices[6] of the entire plant observed at successive stages in the age-cycle, all show a close parallelism. This would lead to the inference that the magnitude of growth is strictly determined by the two *metabolic cardinals*, *viz.*, respiration on the one hand and assimilation on the other; and further that the internal factor for growth, respiration and assimilation appears to be common.

6. Singh, B. N.-*The metabolic basis of growth, senescence and rejuvenescence in plants.* Thesis accepted for the degree of Doctor of Science, Part II, Benares Hindu University, 1927.

7. Inamdar, R. S, and Singh, B. N.—The growth of cotton plant in India. The interpretation of varietal variability of growth in *Gossypium herbaceum* as compared with that of *G. neglectum*. *Ind. Jour. Agr. Sci.*

Analysing the carbohydrate changes[8] at different stages in the age-cycle, the monosaccharides are observed to abound during active metabolism and are condensed to di- and poly saccharides during the quiescent period of growth and respiration, and follow very closely the growth rate and indices of respiration and assimilation curves. Detailed studies on respiration[9] have shown that monosaccharides are the best respirable sugars and a variation in the same corresponds with a variation in the intensity of respiration in different seasons of the year and at different stages of growth. Both the processes of growth and respiration appear to be connected with this internal factor.

The correlated run of many physiological activities as stated above leads unmistakably to the conclusion that there is a connected sequence of metabolic events of the protoplasm during growth. The two questions why the organism shows a general fall in the growth and other metabolic activities with advancing age and a rise before each appearance of the reproductive primordia, are of fundamental importance. It appears that with advancing age the proportion of non living elements inside and outside the protoplasm increases enoromously at an unknown rate, thereby vitiating the calculations of physiological rates and giving their untrue picture.

Organic growth is an increase, organic reduction a decrease in the amount of the substance in the living organism resulting directly or indirectly from its specific metabolic activity, of which respiration, as has been shown, is an important index. An estimate of the functional activity or strictly speaking respiratory activity of that portion of the plant body which is active *i.e.*, meristematic tissues, therefore yields a realistic conception of intrinsic growth potentiality.

8. Singh, B. N., Singh, B & Singh, T. S. N.—The role of the carbohydrate-nitrogen balance throughout the ontogeny of the radish plant, *Proc.* Fourteenth Ind. Sci. Cong, Bot. Sec., Lahore, 1927.

9. Singh, B. N.—*Studies in the mechanism of respiration in plant.* Thesis accepted for the D. Sc. degree Part I, Benares Hindu University, 1927

The experiments[10] on the respiratory indices of meristematic tissues at successive stages of life-cycle indicate that on this basis plants can be segregated into representatives of physiologically distinct classes such as (*i*) short-lived ones Ex. *Pisum sativum, Coriandum sativum, Carum copticum, Foeniculum vulgare, Trigonella foenum graecum, Hibiscus esculentus, Sinapis alba* and *Raphanus sativus*, (*ii*) and long-lived ones Ex. *Gossypium neglectum, Phaseolus vulgaris, Phaseolus multiflorus* and *Cicer arietinum.*

The two classes of plants segregated have a fundamental difference in the behaviour of their meristematic respiratory activity.

The short-lived plants show a characteristic decrease in the respiration rate from an early phase of growth and the rate of fall becomes more pronounced before the initiation of the reproductive organs. Plants with massive root-storage organs such as the Radish show a secondary rise which in its turn is followed by a final decrease. This appears to be characteristic of these plants wherein with the onset of secondary life cycle at the cost of stored materials the activities once more revive.

The long lived forms maintain more or less a level phase in their respiratory rate for a considerably long time after germination and only show a decline towards the fag end of the life-cycle. This behaviour in the meristematic respiratory activity in this class of plants is in keeping with the mode of life of these plants, namely, the power of living for another year or in cases becoming perennials as well.

These findings lead us to the conclusion that the relatively greater decrease in the values of respiration is correlated with the brevity of the life duration while a uniform state in the same corresponds to increased life-duration.

A correlation is also evident between the initial rate of respiration with which the plants start their life activity and their life-duration. The short-lived ones are characterized by a lower initial output of energy in contrast to the compara-

10. Singh, B. N.—The correlation between life duration and respiratory phenomena. *Proc. Ind. Acad, Sci.* Oct. 1935

tively long-lived ones which exhibit a decidedly higher initial rate. A gradation similar to that observed for initial respiration is apparent in the average rates of respiration for the entire life cycle of the plants. Plants covering an age span of about 3 months have a low average respiration, those lasting 5-6 months have a medium average respiration, while the relatively long-lived ones with a life-cycle of over six months have a high average rate of respiratory release. The variations in the life duration are thus to a certain extent traceable to the average rate of respiration during the life-cycle. The duration of life is further correlated with the gradient of the respiratory index of the life cycle *i.e.*, the percentage decline in the respiratory index during the senescent phase from the initial level. The steeper the gradient, the briefer the life-cycle and lesser the gradient the longer the life-span. Considering the value of the initial rate of meristematic respiration as mentioned above, in conjunction with the experimental findings of the growth studies on two varieties of cotton grown in different seasons, the conclusion is obvious that the subsequent growth variability will be predetermined by the intrinsic growth potentiality during the early stage as shown by the initial rate of respiration. This is further elucidated by the values recorded with respect to initial output of CO_2 in successive generations. Thus, *Phaseolus vulgaris*, *Cicer arietinum* and *Coriandrum sativum* show an initial rate of 7.38, 9.12 and 3.3 mgs. respectively in the year 1926-27 while the corresponding values for the same strains grown in the year 1927-28 start with 7.3, 8.7 and 3.1 mgs. respectively. The life duration also remains more or less the same. Further on crossing two pure strains of *N. tabacum* species, the hybrid generation is noted to follow one of the parental forms in its initial meristematic respiration as well as the life duration; the successive generations showing segregation for these characters.

From a study of the ontogenetic drifts in the state of hydration of the meristematic tissues of the two classes of plants mentioned above, it is observed that the difference in the values of the respiration rates is remarkably correlated with a like difference in the state of hydration[11] of these tissues.

The above findings lead us to the following generalizations:

(1) *A decline in the Katabolism and multiplication of the cells in the growing region will tend to approximate the gradient of the hydration of the protoplasm,*

(2) *The state of hydration, in the growing region appears to be governing both respiration and growth,* and

(3) *The potential longevity of any plant is determined by* (i) *rate of metabolic activity and the state of hydration of the protoplasm in the growing region, and* (ii) *genetic constitution.* The functional relations of metabolic activity with temperature, food, light and other environmental factors are well known, while genetic constitution may not be a direct function of the environment for a given organism but a constant which varies with individuals.

With a view to putting these generalizations to more critical tests the intrinsic potentiality of the protoplasm for growth was measured by observing the rate of regeneration or *healing of mechanical wounds in Hibiscus esculentus*[12] at successive stages of its life-cycle. *It is noticed that the relative-rates of respiration, power of callus formation in the founded area (regeneration), and hydration of protoplasm in the tissue show a striking parallelism, indicating a qualitative change in the protoplasm or in other words " a metabolic senescence " of the protoplasm.*

If then a qualitative change in the protoplasm determines senescence, what is the nature of this change. A study of the '*carbohydrate-nitrogen flux*,' in both the reproductive and vegetative parts of the organism,[13] in relation to growth and respiration in varying seasons, *gives a basic for the establishment of the view, that the nature of the food product in*

11. Singh, B. N.—On the intrinsic potentiality of Growth: ontogenetic drifts in the respiratory index of the meristematic tissues in a population crop plants: Hydration factor in respiration and growth. *Proc.* Ind. Sci. Cong. Bot. Sec. 1930.

12. Singh, B. N.—A comparative study of the Respiratory Index, Water-content and the rate of Healing of Mechanical wounds in *Hibiscus esculbentus*, *Jour Ind. Bot. Soc.* 7, 1928.

13. Singh, B. N. *et. al.* Analytic studies into the Dynamics of Carbohydrate nitrogen in the vegetative and reproductive organs of *Artocarpus integrifolia*, *Proc.* Ind. Sci. Cong. Bot. Sec. 1930.

the vegetative organ in relation to protoplasmic hydration is greatly responsible for the appearance and later development of the reproductive organism. The chemistry of the vegetative and reproductive growth appears to be interdependent.

The following conclusions are the outcome of the above analytical study:

(*i*) A low carbohydrate/nitrogen ratio, a high monosaccharide/amino acid ratio, and a higher sugar content are characteristic of greater growth of reproductive organs,

(*ii*) A medium C/N ratio, a medium Mono amino ratio, and medium sugar content accompany moderate growth of vegetative and reproductive parts, and

(*iii*) A high C/N ratio, a high Mono/amino ratio, a high soluble sugar concentration and low water content mark the senescence of the vegetative portion and the ripening of the fruits.

The above results suggest the existence of a balance between carbohydrate and protein Katabolism in the adolescent vegetative phase and the nature of this balance in relation to protoplasmic hydration as being greatly responsible for the appearance and later development of the reproductive organs.

From a consideration of the foregoing facts senescence or ageing has been found to be a characteristic and necessary feature of life, and "death" the inevitable end of this process when regression or rejuvenation does not occur due to certain adverse conditions affecting the colloidal matrix of the living cell. *Senescence and death on the one hand, and rejuvenation on the other, appear to be simply two aspects, of the same dynamic activity.*

Having shown that senescence is associated with a physiological retardation of growth and other metabolic activities, let us endeavour to trace that nature of the retarding influences.

Among the several influences, the lowering in the hydration of the protoplasm, high C/N and Mono/Amino ratios, a gradual drift in the cell sap and water towards the initiation and development of the reproductive organs and a change in the diffusion gradient of gases, water and cell-sap appear to be important.

The relation of water content to the colloidal mass of protoplasm as affecting the metabolic processes and variation in the concentration of cell sap, appears to be the basic principle of growth, although the molecular surface tension and the inhibition of the colloidal mass make the process much complicated. The fact that the water content in the leaves and other organs greatly influences the carbohydrate ratio of polysaccharides to monosaccharides, serves to emphasize the important role which water plays in all the metabolic activities, not to mention of its importance as a promoter of chemical reactions in general.

A fall in the protoplasmic hydration appears to be of great significance in the vegetative growth of the plant. But the vegetative and reproductive phases of plant life are so opposed to each other and so divergent in character that the conditions promoting the one degrade the other. Thus at a time the *Artocarpus* and cotton plants were fully laiden with fruits and bolls respectively, with the appearance of a heavy shower of rain, the fruits and bolls began to shed and the vegetative growth which had almost ceased revived once more in fresh luxuriance.

A shortage in the supply of water has been found to be the cause of the shedding of flowers and fruits in the mango tree[14] and bolls in cotton[15].

The correspondence of the respiratory index curve of the meristematic tissue with that of the hydration on the one hand, and the healing of mechanical wounds[12] on the other, establishes to some degree of accuracy that a *fall in the colloidal hydration of the protoplasm may be one of the several causes leading to cessation of growth processes.*

The fall in water content of the tissue is certainly due to some internal change in the colloidal complex of the protoplasm, for in the preceeding experiments water was always supplied to plants growing under field conditions such that it did

14. Singh, B. N. and Ambegaokar, K. V.—Causal factor in the shedding of mango flowers and fruits: respiration and hydration at different stages of reproductive organs in the mango tree. *Proc. Ind. Sci. Cong.* Bot. Sec. 1931.

15. Singh, B. N.—The causal factor at work in the shedding of flowers and bolls in cotton. *Proc. Ind. Sci. Cong.* Agri. Sec. 1930.

not limit the demand made by the plant. It can therefore be inferred that a fall in the colloidal hydration of the protoplasm, possibly due to some internal factor limits the activity of the protoplasm and thus adds to senility.

Nutrition, as a factor determining senescence deserves attention. How far a fall in the supply of food substratum adds to the decrease in the growth-rate has hardly been directly studied in view of the experimental difficulties involved therein. However, some interesting sidelights on this question have been thrown by the growth studies[16, 17] on Radish, Beet-root and Knol Kohl plants. As contrasted with the growth-rate curves of other plants, the curves of both the respiration and growth-rate in the above cases exhibited two cycles of active growth. The later phase of growth is mainly at the expense of the food materials stored in the fleshy portions of the plants as assimilation was minimal. However, this secondary rise in the growth-rate curve is soon followed by a decline course till finally the penultimate senescent stage and the last stage of senescence overtake the growth-rate. It is thus indicated that the food factor does prolong the life-cycle of the plant if other conditioning factors be not limiting; although senescence may ultimately intervene in spite of the excess of food material.

At any rate, senescence has to be traced ultimately to the failure of the metabolic machinery which is the main vehicle in the process of growth.

While considering the comparative data on growth rate and other metabolic activities in the preceding pages, it was generalized that the correlated run of many physiological activities indicated a connected sequence of events inside the protoplasm during growth and their striking parallel decline with age was interpreted as a general expression of the qualitative change in the protoplasm designated as "*Metabolic senescence*" which affects many physiological activities simultaneously in spite of their diversity. Since respiration has been shown to be an index of the general metabolic activity of the organism and its individual parts, an analysis of the cause bringing about a fall in the working of the respiratory mechanism should throw considerable light on the occurrence of senescence. While engaged in detailed studies on respiration,[9] it was observed that prolonged starvation, anaerobiosis and continued influence of temperature are similar in their effects in depressing the intensity of respiration. Under these conditions for want of a complete working up of the reacting mass to the final CO_2 and water, there is an accumulation of harmful metabolites of the nature of tannins, anthocyanins, flavones, alcohol, aldehydic and ketonic substances and other allied groups. These are found to greatly preponderate in the cell, with advance in age, and affect the respiration as well as the hydrolytic enzymes. Is this production of toxins a normal feature of growth?

Since a close parallelism has been shown to exist between the respiration and growth of plants, as also the growth rate depends on the interconversion of the various groups of carbohydrates, proteins, fats etc., through the medium of specific enzymes of the type mentioned above, it follows that the decline in the growth-rate or, in other words, ageing is due to the progressive accumulation of harmful metabolites, brought about by the not uncommon stresses of anaerobiosis, starvation, high temperatures etc. in nature.

Observations made on the permeability of the plant tissues, as well as the concentration of O and CO_2 within the plant tissue suggest, that with advancing age increase in non-living tissue is a common phenomenon and this ultimately hinders gaseous diffusion O_2 in, and CO_2 out. This being so, anaerobiosis is induced within the tissue and as a consequence of this, CO_2 accumulates as a toxin and thereby decreases the rate of metabolism.

While studying the respiratory mechanism of massive plant organs[18, 19] it has been established that the process of senescence and ripening in these organs go hand in

16. Singh, B. N. and Apte, V. V.—Comparative study of the growth rates and respiration throughout the life cycle of the radish plant. *Proc. Ind. Sci. Cong.* Bot. Sec. 1927

17. Singh, B. N. and Apte, V. V.—Seasonal variations in the growth rate and respiration throughout the life-cycle of knol kohl plant. *Proc. Ind. Sci. Cong.* Bot. Sec. 1927.

18. Singh, B. N.—Localization of a shift in the working of the respiratory system with the march of age in knol kohl tubers. *Proc. Ind. Sci. Cong.* Bot. Sec. 1930.

19. Singh, B. N.—Proposal of a *schema* for the dynamic systems involved in the respiration of oranges and knol kohl tubers. *Proc. Ind. Sci. Cong.* 1930.

hand and are accelarated by the accumulation of CO_2 in the tissue of the flesh.

Experiments on conductivity of wood[20] reveal *that with advance in age of the plant, the channels of translocation for the upward transpiration stream of water and for the downward flow of the manufactured food materials become partly blocked up, such that some of the channels become impervious to the diffusion of gases, cell sap and water.* All these induce a misfit in the demand made by the cell for water and the plastic food material[20] on the one hand, and the supply and removal of accumulated toxic metabolites on the other, *thus following a shortage in the supply of active mass of the reacting substratum, a gradual decrease in the relative velocity of reactions inside the cell and consequently in the rate of metabolism and growth is the net outcome.*

Further the rise in the concentration of the soluble sugar, particularly noted in the case of fruits, and higher C/N and Mono Amino ratios follow the gradient of senescence, and rightly so, since they increase the amount of carbohydrates and reduce nitrogenous matter which is eminently required for the formation of the protoplasm during vegetative growth.

The general fall in the dynamic processes of growth is invariably interrupted by a sudden rise before initiation of the reproductive phase. This "maximal march" in the dynamic processes appears as many times as reproductive organs are produced as in the case of the perennials with the notable exception of one of the varieties of beetroots grown side by side where no such initiation of the reproductive organs took inspite of the appearance of the "maximal hump". *It is noteworthy that in this case, the 'maximal hump' is only indicative of adolescence, the reproductive phase following it as a result of increased metabolic activity, unless the plant be sterile due to certain internal or external causes, even as a girl may attain puberty and yet fail to produce offspring. This increase in the velocity of the dynamic processes culminating in the "Maximum" constitutes the phenomenon of "Rejuvenescence."* Senescence has been traced to the accumulation of harmful metabolites; on this basis *rejuvenescence consists, as indeed experimental evidences point to, after a certain critical stage in the accumulation of metabolites has been reached, in a sudden removal of the metabolites in the form of a backward reaction due to a disturbance in the colloidal mass, resulting in the loss of equilibrium.*

In this connection periodicity *i.e.*, cyclic changes, in growth, needs special mention. Some of the periodic changes may be determined by external factors, while the internal factors are most important. Various plant cells and organs accumulate reserve material. As the accumulation of such reserve materials proceeds they approach quiescence, but if conditions change, they may undergo rejuvenescence. After a period of quiescence, rejuvenescence is but a necessary feature of life. It is quite likely what we call periodicity may simply be associated with the dynamic processes in the alternate accumulation and removal of metabolites.

Summarizing the evidences it may be concluded that longevity is determined to some extent at least, by the state of hydration, and the rate of metabolism of the protoplasm in the sense of the capacity for initial, final and average energy output and also the gradient of decline which the individual exhibits during its life-cycle and for which the momentum is supplied by the potentialities of the uniting germ-cells of the organism. This evidently seems to demonstrate that apart from inheriting the potentiality for morphological characters, an organism also exhibits the potentiality for a certain specific rate of metabolism and thereby the duration of life.

The basis of both senescence and rejuvenescence appears to be to a large extent, the accumulation and a sudden removal of metabolites following the law of mass action—the immediate change in the activity of the organism being brought about as a result of a disturbance in the respiratory mechanism of the organism and in order that senescence be delayed or finally overcome, the resistance to the reaction velocity within the organism must of necessity be diminished by the removal of the toxic metabolites from the centre of activity. When a state of reactivity is reached in which the forward reaction is kept so much in abeyance through the accumulation of harmful metabolites that the reactivity becomes irreversible, "death" then supervenes.

20 Singh, B. N.—and Govande, G. K.—Analytic studies into the ontogenetic drifts in specific conductivity of wood in *Gossypium neglectum* and Maize. *Proc. Ind. Sci. Cong.* Bot. Sec. 1931.

20. Singh, B. N.—*et al.* Transport of the carbohydrate substances in the *Artocarpus integrifolia* plant in different sessons and under varying stresses. *Proc. Ind. Sci. Cong.* 1927.

General Presidential Address—
Indian Science Congress, January 1938

Sir James Jeans
General President of the Congress.

UNTIL a very few weeks ago, we had hoped to assemble here under the Presidency of one of the greatest scientists of all time, and it is inevitable that his sudden and tragic death should be uppermost, not only in the thoughts of those of us who come from Europe, most of whom knew him personally, but in the thoughts of everyone here. For his works had made him known to us all. He has been cut off in the fulness of his powers leaving as his monument a rich and full life's work, such as few men have equalled, but also leaving a feeling that he might have accomplished more, and possibly even greater, things had he been left with us a few years longer.

Those of us who were honoured by his friendship know that his greatness as a scientist was matched by his greatness as a man. We remember, and always shall remember, with affection his big, energetic, exuberant personality, the simplicity, sincerity and transparent honesty of his character, and, perhaps most of all, his genius for friendship and good comradeship. Honours of every conceivable kind had been showered upon him, so that he could not but know of the esteem in which he was held by the whole world, and yet was always simple, unassuming and ready to listen patiently to even the youngest and most inexperienced of his pupils or fellow-workers, if only he were honestly seeking for scientific truth.

This is neither the place nor the occasion to attempt any detailed description of his scientific achievements. A great physicist, Niels Bohr—whom we are sorry not to have with us here—speaking of Rutherford's work to a congress of physicists which recently met in Bologna, said: 'His achievements are so great that, at a gathering of physicists like the one here assembled, they provide the background of almost every word that is spoken.' As it was in Bologna, so it will be in Calcutta; the proceedings in our physics section will be utterly different from what they would have been had Rutherford not lived and worked. And it is sad to think that they will be utterly different from what they would have been had he lived even a few months longer, for then we should have had his ardent and inspiring personality and vast fund of knowledge and experience to direct and enliven our debates. Happily he will not be altogether absent from our meeting. He had been looking forward with the greatest interest and eagerness to this occasion, and had already written a Presidential address for it, which it will be my duty to read to you very shortly.

In this he tells us, in his own words, of his latest work of all—that in nuclear physics, and especially in what he described as 'the new alchemy,' the transmutation of the elements. This alone would have ensured him a place in the foremost rank of physicists, and yet it formed only a small part of the total achievement of his life.

When I first knew him, almost exactly forty years ago, he was experimenting in wireless telegraphy, using a detector of his own invention, and transmitting signals to what was, for those times, the record distance of about a mile and a half.

That was in the period which he used himself to describe as 'the heroic age of physics.' Within the space of a very few years, Röntgen rays were discovered and provided a new line of attack on the problems of electric conduction in gases; the electron was isolated, and seemed to point the way to an understanding of the age-long puzzle of the structure of matter; radio-activity was discovered, with its apparent violation of well-established physical laws, and opened up a new road which led no one knew where—but obviously into very

different territory from that which nineteenth century physics had so industriously and thoroughly explored.

Rutherford directed his colossal energy and tireless enthusiasm on to all these vast new problems in turn. By a few investigations of masterly simplicity, he reduced the puzzling phenomena of radio-activity to law and order, and, in collaboration with Soddy, discovered the physical interpretation of this law and order. Radio-activity, they found, indicated the transmutation of one element into others through processes of spontaneous atomic explosion.

Rutherford then treated the α-particles which were emitted at these radio-active explosions as projectiles. He bombarded atoms with them and in so doing discovered the composition of the atoms. Finally he showed how similar bombardments could change the constitution of the atomic nuclei, and so literally transmute the elements: the dream of the alchemists was realized.

These were perhaps the outstanding landmarks in his career, but in truth most of his invstigations were key investigations, each brilliant in its simplicity of conception, masterly in its execution and far-reaching in its consequences. His output of work was enormous and can only be explained by his capacity for delegating all the less important details of an investigation to a collaborator, whom he usually inspired with his own enthusiasm. In his flair for the right line of approach to a problem, as well as in the simple directness of his methods of attack, he often reminds us of Faraday, but he had two great advantages which Faraday did not possess—first, exuberant bodily health and energy, and second, the opportunity and capacity to direct a band of enthusiastic co-workers. Great though Faraday's output of work was, it seems to me that to match Rutherford's work in quantity as well as in quality, we must go back to Newton.

Voltaire once said that Newton was more fortunate than any other scientist could ever be, since it could fall to only one man to discover the laws which governed the universe. Had he lived in a later age, he might have said something similar of Rutherford and the realm of the infinitely small; for Rutherford was the Newton of atomic physics. In some respects he was more fortunate than Newton: there was nothing in Rutherford's life to compare with the years which Newton spent in a vain search for the philosopher's stone, or with Newton's output of misleading optical theories, or with his bitter quarrels with his contemporaries. Rutherford was ever the happy warrior—happy in his work, happy in its outcome, and happy in its human contacts.

Through the tragic circumstance of his death, I stand before you as your President. I cannot tell you how greatly honoured I feel by your choice, but neither can I tell you how strongly I feel my utter inadequacy to act as substitute for the really great man we had all hoped to have with us here.

Yet I must not forget that I am here in a second capacity also—as spokesman of the Delegation from the British Association. It so happened that I was President of the Association in 1934, when we received your invitation to join you in Calcutta, and I vividly remember how anxious your representatives were to do everything possible to make our visit not only scientifically fruitful, but also pleasurable to ourselves.

I am sure I speak for the whole of the European deputation in thanking you once again for your lavish and carefully-planned hospitality.

To some of us—but only a few—India is well-known territory; others—I think the majority—come here for the first time. But we all feel a special interest in being here for the 25th Anniversary of your Indian Association. The quarter-century of your existence has been a period of stupendous developments in almost all branches of science, and certainly not least in those which have formed my own field of work. Twenty-five years ago the astronomers were still debating as to whether the great spiral nebulae were inside the galactic system or outside; estimates of the distances of these nebulae differed by factors of at least 100, and the vast universe of extra-galactic astronomy was still closed territory. The genius of Einstein had already given us the restricted theory of relativity—the simple physical theory which grew out of the Michelson-Morley experiment—but the more complex gravitational theory was still unborn, and we were still perplexed by its puzzles as to whether the universe was finite

or infinite, and whether space and time were real or unreal. In physics, Planck had given us the rudimentary quantum-theory which was required by the phenomena of black-body radiation, but its application to atomic physics was yet to come. Rutherford's epoch-making investigation on the scattering of α-particles by atoms had just, but only just, shewn us the atom as we see it to-day the heavy nucleus with the cloud of light electrons surrounding it. Bohr immediately seized upon this concept and developed it further; he shewed how the quantum theory could be applied to the movements of this cloud of electrons, and made it yield an interpretation of atomic spectra. On this basis were built first the old quantum-theory and then the far vaster structures of the *new* quantum theory and the wave-mechanics. Finally the new science of nuclear physics came into being, largely as a personal creation of Rutherford; his very last utterance on this subject was written especially for you, and in a few minutes I shall be reading it to you.

Nor has India stood idly by as a mere spectator of this most thrilling period in the history of science. These twenty-five years have not only seen your association increase from infinitesimal beginnings to its present international importance; they have also seen the phenomenal growth of India as a scientific nation. In 1911 there were no Indian-born fellows of the Royal Society; to-day there are four. In 1911 the Royal Society published no papers by Indians, in 1936 we published ten. Yet statistics are dry things, and even those which shew an infinity-fold increase convey a less vivid picture than a few concrete examples, such as each of us can find in abundance in his own subject. The mathematicians and physicists will probably find their thoughts turning, as mine do, to the strangely intuitive genius of Ramanujan and to the remarkable discoveries he had made in pure mathematics before death snatched him prematurely away; to the work of Sir Venkata Raman in physics, and especially his discovery of the effect which is known by his name all the world over; to many investigations in sound and the theory of music made by Raman and a host of others; to the work of Saha in astrophysics, which gave us our first clear understanding of the meaning of stellar spectra, and so unlocked the road to vast new fields of astronomical knowledge; and to the work of many Indians, among whom I would specially mention Chandrasekhar and Kothari, on conditions in the interiors of the stars. And I am sure that not only the mathematicians and physicists, but workers in all other fields as well, will be thinking with admiration of the remarkable ingenuity and experimental skill shewn by that great Indian scientist, the late Sir Jagadish Chandra Bose.

If such names and achievements as these come into the mind of a worker in one only of the many vast fields of science, we can form some slight idea of the richness of India's contribution to science as a whole. Thinking on this great contribution, we of the British Association congratulate you of the Sister Association most wholeheartedly, not only on the completion of your twenty-five years of existence, but even more on the wealth of harvest you have gathered in that twenty-five years.

Lord Rutherford's Address

Introduction

DURING the past fifty years, the British Association for the Advancement of Science has been invited on many occasions to hold its meetings overseas. Four times it has journeyed to Canada (Montreal 1884, Toronto 1897, Winnipeg 1909, Toronto 1924), twice to South Africa (1905, 1929), once to Australia (1914). This policy of the Association of arranging occasional meetings in our Dominions has proved an unqualified success. These overseas visits have had a marked influence on the progress of science throughout our Commonwealth and by personal contacts have helped much to promote mutual understanding and cooperation between our peoples.

The visit of a representative group of scientific men to our most distant Dominions in 1914, in itself an outstanding event in the history of the Association was rendered even more notable by the dramatic circumstances under which the meetings were held, for the arrival of the party in Australia coincided with the news of the outbreak of the Great War. Anyone who like myself took part

in the meetings in Australia and New Zealand in those troubled but stirring times can never forget the warmth of our reception. We were privileged to witness that wonderful response of the peoples of these lands to the call of danger a response which we know grew ever greater with the need.

It has long been the wish of the British Association to hold a meeting in India, and difficulties of time and climate alone have stood in the way of its realization. It has been found most convenient for the overseas visits to take place in the summer months but such a time is quite unsuitable for India. This difficulty would be in part surmounted if a representative party of scientific men could obtain leave of absence from their duties to visit India during the cold weather.

The celebration of the Silver Jubilee of the founding of the Indian Science Congress Association offered a suitable occasion for such a visit, and arrangements have been made through the two Associations to hold a joint meeting in India. I gladly accepted the invitation of the two bodies to preside over this combined meeting. I feel it not only a great honour but a great privilege and responsibility to be asked to fill this post on such an historic occasion. This visit of the British Association to your shores is a symbol of our desire to extend the hand of greeting and fellowship to our sister society and also individually to our co-workers in science in India.

While science has no politics, I am sure it is of good omen that our visit happens to fall at a time when India is entering upon a new and important era of responsible cooperative government in the success of which both our countries are deeply concerned.

On behalf of the British Association, I extend to the Indian Association our warmest congratulations on this the twenty-fifth anniversary of its foundation and our sincere wishes for its continued success. We recognize that your Association, both in its constitution and its aims so closely resembling the British Association, has proved of great service to the progress of science throughout India. Founded at a time when the universities were becoming centres of original research, it afforded to a widely scattered scientific community a much needed common meeting ground for the discussion of scientific problems. It helped also to bring to the attention of the interested public the importance of science and of the scientific method in national development. I think it can be safely stated that the success of the meetings of the Indian (Science Congress) Association in no small degree influenced the later foundation of specialist societies in India, for example, the Chemical Society and Physical Society.

On such an occasion as this, we must not forget to do honour to those who were largely instrumental in founding your Association and in guiding its infant steps. I would refer in particular to Professor Simonsen, Profesor McMahon and your first President Sir Sydney Burrard.* The Association owed much in its early days to the friendly support and encouragement so freely given by that premier Indian Society, the Royal Asiatic Society of Bengal of which I am proud to be an honorary member.

Work of the Indian Scientific Services

In earlier days in India, research was largely confined to the great scientific services, initiated and maintained on a generous scale by the Indian Government, for example, the Survey of India, the Geological Survey, the Botanical Survey, the Departments of Agriculture and Meteorology and many others.† Pioneer work of outstanding scientific importance has been done by all these services. In the short time at my disposal, I can only make a passing reference to a few items of work accomplished, and can mention only a few of the array of distinguished names which have been connected with these great scientific services.

The Trigonometrical Survey of India has a long and distinguished history. The splendid series of geodetic measurements along an arc from Cape Comorin to the Himalayas, made by Everest, was of outstanding importance and his name is for ever associated with the highest peak in the world. As a result of this survey, the deflections of a plumb line, due to the gravitational attraction of

* The first President was the late Sir Asutosh Mookerjee. Sir Sydney Burrard presided in 1916 *Ed. Sc. & Cul.*

† For the accounts of these *vide* SCIENCE & CULTURE, Vol 3, No 6, Supplement.—*Ed.*

the Himalayan range, were determined at different points. A careful comparison of the results of observation with calculation, largely due to the work of Archdeacon Pratt of Calcutta and later of Sir Sidney Burrard, disclosed marked discrepancies, the effect of the mountain mass at a distance being much less than was expected. Attempts to explain these and other anomalies ultimately led to the formulation of a new and important theory of mountain formation known as the principle of isostasy. On this hypothesis, the excess pressure due to a mountain mass is compensated for by a deficiency of matter below its base. This conclusion which is in accord with extensive gravitational as well as geodetic measurements in India, is believed to be of general application to mountain formation throughout the world.

I may recall that a former distinguished Superintendent of this Survey, Sir Gerald Lenox Conyngham is Head of the Department of Geodesy in Cambridge.

The Geological Survey, one of the oldest scientific services in India, has a fine record of work accomplished and its survey of the mineral resources of India has proved of great value to Indian industry. Among many distinguished names, I may specially mention that of Sir Thomas Holland, a former Director, who has done such good work for your country in peace and war. I believe that it was largely due to his energy and scientific insight that the great Tata Iron and Steel Works were begun.*

The Department of Meteorology has done much pioneering research and was one of the first to realize the importance of studying the conditions of the upper air by means of small balloons—a subject of ever increasing importance with the advent of the aeroplane. I have always felt a certain connection with this Department as many of its members are known to me personally. Amongst them is Sir Gilbert Walker, a former Director and once President of this Association, who did much to improve the Meteorological Service in India and himself made important original contributions to our knowledge of the South-West Monsoon. I may recall that the present distinguished head of the Meteorological Office of Great Britain, Sir George Simpson, was for many years a member of this Indian Department.

The study of the botanical riches of India owes much to the work of Roxburgh, Wallich and Prain, and also that explorer and naturalist Hooker, whose work on the flora of British India is known to you all.

In Forestry, India has at Dehra Dun probably the finest research laboratory of its kind in the world. We in England owe a debt of gratitude to India in providing us with our distinguished Professor of Forestry at Oxford, Professor R. S. Troup, and the first two directors of our Forest Products Laboratory, namely Sir Ralph Pearson and Robertson.

While in this brief survey I can only mention a few departments out of many, yet I must not omit to refer to the great advances in knowledge due to the Indian Medical Service, so well represented by the pioneer work of Ross on malaria and by Leonard Rogers on cholera and leprosy, researches which gave new hope to the people of India.

Beginning of Teaching of Science in India

In the early days of the Indian universities, attention was mainly directed to teaching and examining the large number of students who presented themselves and comparatively little attention was paid to research. There were always a few, however, who recognized that the universitie.. had a wider part to play in Indian education, and should become centres of research as well as of teaching. Amongst those pioneers who distinguished themselves by original investigations and by the stimulation of others, I should particularly mention Sir Alexander Pedler, Sir Alfred Bourne, Sir Jagadis Bose and Sir Prafulla Ray and it is of interest to recall that the last three have all been presidents of your Association.

As a result of the Curzon Commission on education in 1904, many of the universities introduced Honours courses, and by new appointments and

* For a history of the Tata Iron and Steel work, see life of J. N. Tata by F. R. Harris (Oxford University 1925.)—*Ed.*

improvements in laboratories stimulated research in science. Excellent well equipped schools of research have arisen in many Indian universities, where good opportunities are available for the training of potential investigators in the methods of research. The Indian student has shown his capacity as an original investigator in many fields of science, and in consequence India is now taking an honourable part and an ever-increasing share in the advance of knowledge in pure science.

Some outstanding Indian Workers in Science

Amongst many workers of distinction, I may specially mention Sir Venkata Raman, Professor Saha and Professor Sahni each of whom has made outstanding contributions. That premier scientific society of Great Britain, the Royal Society, has recognized the value of their work by election to its Fellowship.

We in Great Britain watch with pride this growth of the scientific spirit in India and are pleased to help in any way we can. As an example of our interest, I may recall that Trinity College, Cambridge--my own college--assisted that mathematical genius Ramanujan to continue his studies in Cambridge. He was soon elected a Fellow of that College and a Fellow of the Royal Society. But for his premature death, it may be said of him, as Newton said of Cotes, that we had known something.

The researches in astrophysics of Chandrasekhar in Cambridge were at once recognized by the award to him of an Isaac Newton Studentship and later by his election to a Fellowship in Trinity College.

The 1851 Exhibition Scholarship

As a member of the Royal Commission for the Exhibition of 1851,* I would like to refer to some events this year of special interest to India. This Commission awards each year a number of Overseas Scholarships to our Dominions as well as Senior Research Studentships open to competition in England by all members of our Commonwealth. The opportunity offered by these scholarships to promising investigators from overseas to continue their work in England or abroad has proved of great value to the progress of science. I am proud to remember that I myself was awarded an 1851 Scholarship on the recommendation of the University of New Zealand.

It has for some time been the wish of the 1851 Commission to be able to offer one or more of its Overseas Scholarships for award to students in India. Owing to difficulties of finance, it was only this year that this project was realized. A preliminary committee of selection was set up in India and the Commissioners with whom lay the final choice have appointed Mr. N. S. Nagendra Nath of the Indian Institute of Science, Bangalore, as the first 1851 Exhibition Scholar from India. He has come to Cambridge to carry out investigations in Theoretical Physics. For the first time also, an Indian student in Cambridge Dr. H. J. Bhabha has been awarded in open competition one of our valuable Senior 1851 Studentships in recognition of the importance of his researches in theoretical physics. The Commission would like to be in a position to allot a second science scholarship to India but funds are insufficient. The machinery however is there and I know that the Commissioners would be only too happy to administer a second award if anyone in India who is interested in her scientific progress were generous enough to provide the necessary endowment.

Future Rôle of Science in National Life

While as we have seen, the universities of India have in later years made substantial progress both in teaching and research in science, yet it must be borne in mind that still greater responsibilities are likely to fall on them in the near future. This is in a sense a scientific age where there is an ever-increasing recognition throughout the world of the importance of science to national development. A number of great nations are now expending large sums in financing scientific and industrial research with a view to using their natural resources to the best advantage. Much attention is also paid to the improvement of industrial processes and also to conducting researches in pure

* Editorial Note—See in this connection, SCIENCE & CULTURE, Vol I, pp. 480-82. —*Ed. Science and Culture.*

science which it is hoped may ultimately lead to the rise of new industries.

It is natural to look to the universities and technical institutions for the selection and training of the scientific men required for this development. In India, as in many other countries, there is likely to be a greater demand in the near future for well trained scientific men. With the growth of responsible government in India, it is to be anticipated that the staff required for the scientific services in India and for industrial research will more and more be drawn from students trained in the Indian universities. It is thus imperative that the universities should be in a position not only to give a sound theoretical and practical instruction in the various branches of science but, what is more difficult, to select from the main body of scientific students those who are to be trained in the methods of research. It is from this relatively small group that we may expect to obtain the future leaders of research both for the universities and for general research oganizations. This is a case where quality is more important than quantity, for experience has shown that the progress of science depends in no small degree on the emergence of men of outstanding originality of mind who are endowed with a natural capacity for scientific investigation and for stimulating and directing the work of others along fruitful lines. Leaders of this type are rare but are essential for the success of any research organization. With inefficient leadership, it is as fatally easy to waste money in research as in other branches of human activity.

Training and Maintenance of the Research Worker

The selection of such potential investigators and leaders is not an easy task, for success in examinations in science is no certain criterion that the student is fitted for a research career. A preliminary training in research methods for a year or two is required to select those who possess the requisite qualities of originality and aptitude for investigation. A system of grants in aid or scholarships to approved students may be required for such postgraduate training. In Great Britain the financial help given by the universities and other educational institutions for training in research is in many cases supplemented by maintenance grants to promising students, awarded by the Department of Scientific and Industrial Research. This system has proved of much value both in developing the research activities of the universities and in providing a supply of competent men both for research in pure science and in industry.

I have so far mentioned some aspects of the scientific work carried out by the universities and Government services of India. I am well aware that much attention has also been directed to the need of scientific research in agriculture, and in certain industries. A cotton research association has been set up which has given admirable service, while the Indian Lac Institute arranges for investigations in that unique Indian product, some of which are carried out in Great Britain. I am interested to know that an agricultural research council has recently been formed, largely as a result of the findings of a Commission of which His Excellency the Viceroy was Chairman.

Need of National Planning

While I cannot lay claim to have any first-hand knowledge of Indian industries and conditions yet I may be allowed to make some general observations on the importance in the national interest of a planned scheme of research in applied science If India is determined to do all she can to raise the standards of life and health of her peoples and to hold her own in the markets of the world, more and more use must be made of the help that science can give. Science can help her to make the best use of her material resources of all kinds, and to ensure that her industries are run on the most efficient lines. National research requires national planning. If research is to be directed in the most useful direction, it is just as important for a nation as for a private firm to decide what it wishes to make and sell. It is clear also that any system of organized research must have regard to the economic structure of the country. One essential fact at once stands out. India is mainly an agricultural country, for more than three quarters of her people gain their living from the land, while not more than three per cent are supported by any single industry. A glance at the

official review of the trade of India shows that the annual production of wheat has risen since 1914 from about 8.3 to 9.5 million tons while exports in the same period have fallen from 1.2 million tons to 10,000 tons. In the case of another important food, rice, the Indian production, exclusive of Burmah, has remained fairly steady, varying between 22 and 25 million tons annually but here also exports have fallen from about half a million tons before the War to about 200,000 tons.

In view of these facts, it would seem clear that, in any national scheme of research, research on foodstuffs has a primary claim on India's attention. Quite apart from improvements in the systems of agriculture used in India, there is a vast field for the application of scientific knowledge to the improvement of crops, for example, by seeking for improved strains suitable for local conditions, by research on fertilizers and in many other directions. The fact that surplus wheat for export has decreased suggests that the present production is required for home consumption in India. When the permanent schemes of irrigation now in hand bring much more land under full cultivation, India may again wish to take her place in the import market. To do this in the face of international competition, well planned agricultural research will be essential.

While the character of India's exports has seen many changes in the last hundred years, to-day exports of cotton, jute and tea amount to about 60 per cent of the total exports of India. Next in importance come oil and seeds 6 per cent, hides 5 per cent and lac 1 per cent. There is no doubt that more scientific knowledge would increase the production of all these things. There is of course the need to make sure that there is a market for such surplus. Of India's staple exports, cotton represents about 20 per cent of the total value. It is characteristic of Indian cotton that the staple is short and, until the cultivation of better varieties is more general, no competition will be possible with cottons of the American type, and trade must mainly be confined to the Indian market and the far Eastern countries. Here there appears to be a wide field for applied research. Good work has been done by the Indian Cotton Committee which has taken steps to improve the staple and prevent adulteration and inter-mixture of various varieties. The problem can be approached, however, not only in the seeking of better varieties but in finding uses and methods of treatment for the short staple variety. The importance of research on the cotton itself is well brought home by the results achieved in the United Kingdom. The Cotton Research Association there has found that many of the defects which appear in the finished article can be traced back to defects in the raw material.

Need of a Radio Research Board of India

Finally a word might be said concerning the need for research on radio communication, so important a matter to a large country like India. I do not refer to technical research in transmitting and receiving apparatus, but rather to the type of fundamental investigation pursued under the Radio Research Board in Great Britain. These investigations, begun in the early days after the War, have shown that the propagation of radio-waves over large distances is very dependent on the electrical state of the upper atmosphere. It is now established that a number of electrified layers exist in the higher atmosphere which under certain conditions are able to reflect electric waves. The details of this electrical distribution vary considerably with the hour of the day and with the season of the year, as well as with geographical location. Such information, which is of practical importance in the selection of the most suitable wave-lengths for radio-communication, must obviously be secured by research conducted in the country itself. Moreover, it does not seem impossible that such a survey may prove of value in long-range weather forecasting.

There is here then much scope for research in a wide field, which I hope will be pursued vigorously in India. It is pleasant to note that a more promising stage in tackling fundamental radio problems of this character has already been made here by Professors M. N. Saha and S. K. Mitra and their students. The importance of survey work of this kind has already been recognized in other parts of the Empire where it has received official support and encouragement. I will refer in particular to the admirable work in this field by the Radio Research Board of Australia.

Industrial Research in Great Britain

While I recognize the great differences which exist between the industrial and agricultural conditions in Great Britain and India, yet it may prove of some interest and, I hope, of some value, if I give a brief account of the ways in which the British Government has aided scientific and industrial research in the period following the Great War. From the dawn of the scientific age, Great Britain has taken a prominent place in advancing knowledge both in pure research in our universities and in applied research for the development of industry. Before the War, progress in industry depended in the main on the brilliant contributions of individual workers rather than on any systematic attack by scientific methods on the problems of industry. We may instance the pioneer work of Bessemer for the steel industry and of Parsons in the development of the steam-turbine which had such a great effect on the power-industry. One cannot pay too high a tribute to the greatness of the achievements of these individual inventors and investigators, for it was largely due to them that Great Britain obtained such a great industrial position in the last century. Yet I think it is true to say that in the period before the War the country as a whole failed to recognize as fully as some other nations the importance of an organized scientific attack on broad lines on the problems of industry. In a number of cases, British Science gave ideas to the world, but it was left to other nations to develop them by intensive research and to reap the industrial benefit.

Need of Cooperation between Scientist and Industrialist

This weakness in our organization became apparent in the War when the production of munitions and materials threw a great strain on industry. The common danger brought the industrialist and man of science into close cooperation to their mutual benefit. The results of this cooperation surpassed all expectation. New chemical processes were evolved, many new devices arose while communications were revolutionized by the rapid development of the thermionic valve. In a hundred different ways, the cooperation of science with industry had justified itself by its success.

State Organization of Research

Early in the War, the British Government recognized that, when peace came, a more systematic application of science and research over a broader field was essential in the national interest and, amid the distractions of war, set up the necessary machinery to accomplish this. In 1915 the Department of Scientific and Industrial Research was formed, and a few years later, in 1920, the Medical Research Council was set up to undertake investigations in all matters connected with the health of the people These were followed by the formation in recent years of the Agricultural Research Council. The formation of the D.S.I.R. marked the first comprehensive and organized measure taken in Great Britain to help industry generally through the application of science. A number of new research organizations were set up, controlled and financed by the Department to deal with the scientific aspects of the use of fuel, of the storage and transport of food, of building and later of roads subjects of great importance to the common welfare of the people but on which little if any organized research had been undertaken.

Fuel Research Board

Coal is the greatest material asset possessed by Great Britain for on it mainly depends the heating of our homes and the production of power for most industries. Its better utilization is a problem of great national importance. To achieve this purpose the Fuel Research Board was formed and a large laboratory was erected at Greenwich to carry out investigations on the better and more economic use of coal. An important section of this work is a national survey of the coal resources of Great Britain carried out in special laboratories in the several coalfields. The properties of the coal in the various seams are carefully examined and, if necessary, full scale trials are made at the Fuel Research Station to test the suitability of the coal for carbonization, for steam raising or for conversion into oil. The results of this survey which is still in progress, have proved of increas

ing value not only to the colliery owner and the industrialist but also for the needs of the export trade.

Research in Building

In Great Britain every year upwards of 100 million pounds are spent on the erection of new buildings and in maintaining old ones, yet no organized research on building had been made. To remedy this deficiency, the Department set up a Building Research Station near London where investigations are made on the many and varied problems connected with the better housing of the people. For example, investigations are carried out to find scientific explanations of the traditional practices which have grown up in the building trade, for on this depends a rational adjustment of materials and methods to meet modern needs. The results of such a scientific enquiry in this comparatively unexplored field cannot fail to have a marked influence on building construction generally.

The Building Research Station embraces in its programme all problems connected with building materials except those associated with the use of timber. These are dealt with at another establishment of the Department, the Forest Products Research Laboratory. Here intensive researches are carried out on the best use of timber and its preservation. The country spends large sums annually on timber, much of it imported, and in the national interest it is of great importance to us that the best value is obtained for this outlay.

The Food Investigation Board

You are all aware that food represents one of Great Britain's largest imports and much of this is transported great distances from overseas. An organization was set up known as the Food Investigation Board to consider the best methods of storage and transport of food, so as to avoid waste and loss of nutritive value. Much of this work has its centre at the Low Temperature Research Station in Cambridge, but a special station at Torry, Aberdeen, deals with the preservation of fish and another at Ditton in Kent with the storage of fruit. Investigations in this field, which owe so much to the initiative of the later Sir William Hardy, have proved very valuable in many directions, and have led to great improvements in the conditions of transport and storage of a great variety of foodstuffs.

The Refrigerated Gas Storage Method

I may give one example out of many of the striking consequences of such researches. The Low Temperature Research Station found that beef in a chilled state could be safely stored for 60 or 70 days in a suitable atmosphere of carbon dioxide. The importance of this discovery, which enabled beef to be carried in first rate condition from our most distant dominions, was at once recognized by the interests concerned. The first shipment of chilled beef carried by this new method of gas storage was landed in 1929 from New Zealand. Since that time, shipments have steadily increased and most of the vessels built for the Australasian trade have now chambers specially constructed for transport in gas storage.

Road Research Board

While the development of our roads in the past owes much to the pioneer work of men like Macadam and Telford, there was no planned organization to add to our knowledge of road construction until comparatively recent years, when the Road Research Station was set up at Harmondsworth, near Slough, to deal with problems of road construction and the study of road wear under modern conditions of traffic. When we consider the large sums spent every year on the construction and maintenance of roads, the need of such scientific investigation is obvious.

The group of research organizations so far considered deals with the primary needs and interests of the people as a whole as regards food, fuel, building and roads. No independent establishment was set up to deal with another important need of the people, namely clothes, for this is most appropriately provided for by the large research associations which have been instituted in connection with the cotton, wool, and linen industries.

The National Physical Laboratory

Of the national organizations under the charge of the Department, the largest and probably the most important is the National Physical Laboratory at Teddington, which covers about 50

acres and employs a staff of nearly 700 persons. The work of this Laboratory, primarily intended for the assistance of industry in general, covers a very wide field. It has eight great departments devoted to the study of the different branches of Physics, Electrotechnics, Engineering, Metallurgy and Metrology, Radio communications, Aero-dynamics and the investigation of ship design. The Laboratory is responsible for the maintenance of the National Standards and for refined measurements connected with them. It is not always realized to what a great extent modern mass production depends on the maintenance of exact standards, and the Laboratory plays an important part in testing the accuracy of gauges so necessary in modern industry.

In 1925 a Chemical Research Laboratory was set up at Teddington in which pioneer work is being carried out on chemical reactions at high pressures and temperatures and in the production of synthetic resins. Another important problem in which the Department is interested is the provision of more plentiful supplies of pure water for domestic and industrial consumption. Valuable work has been done by the Water Pollution Research Board in many directions and new methods have been found for the purification of water which has been contaminated by the industrial effluents from sugar and milk factories.

I have so far mentioned research organizations which have been set up to encourage the application of science to problems which affect the daily life of the people and the nation's industries considered as a whole. I should mention that these national organizations to which I have referred are not only willing but anxious to cooperate with corresponding institutions which may be set up in India or the Dominions.

Cooperative Research Associations

I must now refer to arrangements which have been made to promote the application of scientific knowledge to the problems of the individual industries. The importance of research has long been recognized by large industrial companies, who have in many cases set up research establishments for their own requirements. This tendency is specially marked in the Electrical and Chemical Industries where large sums are spent annually on research.

It is, however, to be borne in mind that a great part of British industry is carried out in small establishments. A survey carried out some years ago indicated that in 128,000 factories in Great Britain less than 500 employed more than 1000 workers while over 117,000 employed less than 100 workers. Obviously such small factories are not in a position to maintain a research laboratory on anything but a small and inefficient scale. To overcome this difficulty, the Department in conjunction with industry instituted a number of cooperative research associations representing the greater part of the main industries of the country. Each of these research associations is autonomous and controlled by representatives of the industry concerned, and is financed by contributions from the firms belonging to the association, assisted by grants from the Department.

This bold experiment in the cooperative organization of research which is unique in the world, has undoubtedly proved a great success. Today there are twenty such research associations formed on a national basis in their respective industries and for membership of which all British firms are eligible. They cover the metal and textile industries, paint, leather, boots and shoes, rubber, flour milling, cocoa and confectionery, food, printing, scientific instruments and the automobile and electrical industries. From small beginnings, a number of these associations have steadily grown in size and strength until they now form an indispensable and valuable part of the industries they represent.

Research Increases Industrial Efficiency

I can speak with some knowledge of the marked progress made by these two types of research organization, as I have been privileged, as Chairman of the Advisory Council of the Department of Scientific and Industrial Research for the past 8 years, to come in close contact with them. While much still remains to be accomplished, there has been a great advance in recent years in the recognition of the value of research in increasing the efficiency of industry. If we are to hold our own in face of the ever increasing com-

petition in the world today, it is essential that our industries should take full advantage of the resources which science places at their disposal.

National Research Councils in the Dominions

It is of interest to note that the Overseas Dominions have not been slow to appreciate the importance of such national organizations in the development of their national resources and industries. Healthy research organizations under the control of National Research Councils or corresponding bodies have been set up in Canada, Australia, New Zealand and South Africa. Both in Canada and Australia which have a Federal system of government, the research organization is national in the true sense of the word and responsible only to the central Government.

Necessity of Research Organizations in India

It is to be borne in mind that the organization of research for industry and for general national purposes varies much in different countries. A research organization which may prove adequate for a country like Great Britain may prove quite unsuitable for another country with different needs and different industrial conditions. In developing any organized scheme of research, each country must consider its own resources and its own particular requirements. As we have seen, the organizaaion of research not only in Great Britain but in the Dominions, is national in scope. Even in a large country like India, where the resources and needs of the different Provinces are very varied, it seems to me essential for efficiency that the organization of research should be on national rather than on provincial lines. The setting up of separate research establishment for similar purposes in the various provinces cannot but lead to much overlapping of work and waste of effort and money. Such a central organization of research does not necessarily mean that the scientific work should all be concentrated in a single laboratory. For example, I understand that a single organization is responsible for the research in cotton for the whole of India. While the more fundamental research is done at a conveniently situated laboratory, much of the work of a special character is carried out in the provinces where cotton is grown.

How to Plan Programmes of Research

In Great Britain, the responsibility for planning the programmes of research, even when the cost is borne directly by the Government, rests with research councils or committees who are not themselves State servants but distinguished representatives of pure science and industry. It is to be hoped that if any comparable organization is developed in India, *there will be a proper representation of scientific men from the universities and corresponding institutions and also of the industries directly concerned.* It is of the highest importance that the detailed planning of research should be left entirely in the hands of those who have the requisite specialized knowledge of the problems which require attack. In the British organizations there is no political atmosphere but of course the responsibility for allocating the necessary funds ultimately rests with the Government.

In this address, I have to a large extent confined my attention to research in pure science, agriculture and industry. I am, however, not unmindful of the pressing needs of India to alleviate the sufferings of the people from attacks of malaria and other tropical diseases. I know that India herself is giving much thought to these vital problems in which science can give her valuable help.

Transmutation of Matter

I have so far spoken of the importance of science as a factor in national development, but before concluding my address, I would like to refer to some investigations in pure science in which I have been personally much interested. I refer to the successful attack on that age-old problem of the transmutation of matter which in recent years has attracted so much attention from physicists throughout the world.

I hope it may prove of interest to give a brief account of the successive stages of the growth of our knowledge of this subject, for it illustrates in a striking manner the power of the scientific method of attack on what at first appeared to be an insoluble problem. Incidentally these researches have yielded us precious information on

the structure of all atoms and indeed it seems likely to have provided us with a key, so to speak, to unlock the secrets of the constitution of our material world.

Towards the close of the nineteenth century, when it seemed certain that the atoms of the elements were unchangeable by the forces then at our command, a discovery was made which has revolutionized our conception of the nature and relations of the elements. I refer to the discovery in 1896 of the radioactivity of the two heaviest elements uranium and throium. It was soon made clear that this radioactivity is a sign that the atoms of these elements are undergoing spontaneous transmutation. At any moment, a small fraction of the atoms concerned become unstable and break up with explosive violence, hurling out either a charged atom of helium, known as an α particle, or a swift electron of light mass called a β-particle. As a result of these explosions, a new radio-active element is formed and the process of transmutation once started continues through a number of stages. Each of the radioactive elements, formed in this way, breaks up according to a simple universal law but at very different rates. In a surprisingly short time, these successive transformations were disentangled and more than 30 new types of elements brought to light while the simple chemical relations between them were soon made clear.

We had thus been given a vision of a new and startling sub-atomic world where atoms break up spontaneously with an enormous release of energy quite uninfluenced by the most powerful agencies at our disposal. Apart from uranium and thorium and the elements derived from them, only a few other elements showed even a feeble trace of radioactivity. The great majority of our ordinary elements appeared to be permanently stable under ordinary conditions on our earth. Science was faced with the problem whether artificial methods could be found to transmute the atoms of the ordinary elements. Before this problem could be attacked with any hope of success, it was necessary to know more of the actual constitution of atoms. This information was provided by the rise of the nuclear theory of atomic structure which I first suggested in 1911. The essential controlling feature of all atoms was found to reside in a very minute central nucleus which carried a positive charge and contained most of the mass of the atom. A relation of unexpected simplicity was found to connect the atoms of all the elements. The ordinary properties of an atom are defined by a whole number which represents the number of units of resultant positive charge carried by the nucleus. This varies from 1 for hydrogen to 92 for the heaviest element uranium and with few exceptions all the intervening numbers correspond to known elements.

On this view of atomic structure, it was evident that, to bring about the transmutation of an atom, it was necessary in some way to alter the charge or mass of the nucleus or both together. Since the nucleus of an atom must be held together by very powerful forces of some kind, this could only be effected by bringing a concentrated source of energy of some kind to bear on the individual nucleus. The most energetic projectile available at that time was the swift α-particle spontaneously ejected from radioactive substances. If a large number of α-particles were fired at random at a sheet of matter, it was to be expected that one of them must occasionally approach very closely to the nucleus of any light atom in its path. In such a close encounter, the nucleus must be variously disturbed and possibly under favourable conditions the α-particle might actually enter the nuclear structure.

This mode of attack upon the nucleus at once proved successful. I found in 1919 that nitrogen could be transformed by bombardment with fast α-particles. The process of transmutation is now clear. Occasionally an α-particle actually enters the nitrogen nucleus and forms with it a new unstable nucleus which instantly breaks up with the emission of a fast proton (hydrogen nucleus) and the formation of a stable isotope of oxygen of mass 17. About a dozen of the light elements were found to be transformed in a similar way. The protons liberated in the nuclear explosions were at first counted by observing the flashes of light (scintillations) produced in phosphorescent zinc sulphide. This method was slow and very trying to the eyes of the observers. Progress however became more rapid and definite when

electrical methods of counting individual fast particles were developed. These electrical counters, mainly depending on the use of electron-tubes for magnifying small currents, have now reached such a stage of perfection that we are able to count automatically individual fast particles like α-particles and protons even though they enter the detecting chamber at a rate as fast as ten thousand per minute. By other special devices, we are in like manner able to count individual β-particles. In this connection, I must not omit to mention that wonderful instrument the Wilson Expansion Chamber which makes visible to us the actual tracks of flying fragments of atoms resulting from an atomic explosion. These remarkable devices have played an indispensable part in the rapid growth of knowledge during the last few years. It is to be emphasised that progress in scientific discovery is greatly influenced by the development of new technical methods and of new devices for measurement. With the growing complexity of science, the development of special techniques is of ever increasing importance for the advance of knowledge.

Up to the year 1932, experiments on transmutation were confined to the use of α particles for bombarding purposes. It became clear that the process of transformation was in most cases complex since groups of protons with different but characteristic energies were observed when a single element was bambarded. This led to the conception that discrete energy levels existed within a nucleus and that under some conditions part of the excess energy was sometimes released in the form of a quantum of high frequency radiation.

The stage was now set for a great advance, and four new discoveries of outstanding importance were made in rapid succession in the period 1931-33. I refer to the discovery of the positive electron by Anderson in 1931, of the neutron by Chadwick in 1932, of artificial radioactivity by M. and Mme. Curie-Joliot in 1933 and of the transmutation of the elements by purely artificial methods first shown by Cockcroft and Walton in 1932.

The discovery of the neutron—that uncharged particle of mass nearly 1—was the result of a close study of the effects produced in the light element beryllium when bombarded by α-particles. It is noteworthy that the proton and neutron, which are now believed to be the essential units with which all atomic nuclei are built up, owe their recognition to a study of the transmutation of matter by α-particles.

Before the discovery of the neutron, it had been perforce assumed that nuclei must in some way be built up of massive protons and light negative electrons. Theories of nuclear structure become much more amenable to calculation when the nucleus is considered to be an aggregate of particles like the proton and neutron which have nearly the same mass. There was no longer any need to assume that either the positive or the negative electron has an independent existence in the nuclear structure. We are still uncertain of the exact relation, if any, between the neutron and the proton. The neutron appears to be slightly more massive than the proton but it is generally believed, although no definite proof is available, that the proton and neutron within a nucleus are mutually convertible under certain conditions. For example, the change of a proton into a neutron within the nucleus should lead to the appearance of a free positive electron, while conversely the change of a neutron into a proton gives rise to a free negative electron. In this way it appears possible to account for the observed fact that either positive or negative electrons are emitted by a large group of radioactive elements to which I will now refer.

In the early experiments on transmutation by α particles, it was supposed that a stable nucleus was always formed after the emission of a fast proton. The investigations of M. and Mme. Curie-Joliot showed that in some cases elements were formed which, while momentarily stable, ultimately broke up slowly, exactly like the natural radioactive bodies. Most of these radioactive bodies formed by artificial methods break up with the expulsion of fast negative electrons but in a few cases positive electrons are emitted. Since the presence of these radioactive bodies can be easily detected, and their chemical properties readily determined, this new method of attack on the

problem of transmutation has proved of great value. Nearly a hundred of these radioactive bodies are now known, produced in a great variety of ways. Some arise from the bombardment by fast α-particles, others by bombardment with protons or deuterons. As Fermi and his colleagues have shown, neutrons and particularly slow neutrons are extraordinarily effective in the formation of such radioactive bodies. On account of its absence of charge, the neutron enters freely into the neuclear structure of even the heaviest element and in many cases causes its transmutation. For example, a number of these radioactive bodies are produced when the two heaviest elements uranium and thorium are bombarded by slow neutrons. In the case of uranium, as Hahn and Meitner have shown, the radioactive bodies so formed break up in a succession of stages like the natural radioactive bodies, and give rise to a number of trans-uranic elements of higher atomic number than uranium (92). These radioactive elements have the chemical properties to be expected from the higher homologues of rhenium, osmium and iridium of atomic numbers 93, 94 and 95.

These artificial radioactive bodies in general represent unstable varieties of the isotopes of known elements which have a limited life. No doubt such transient radioactive elements are still produced by transmutation in the furnace of our sun where the thermal motions of the atoms must be very great. These radioactive elements would rapidly disappear as soon as the earth cooled down after separation from the sun. On this view, uranium and thorium are to be regarded as practically the sole survivors in our earth of a large group of radioactive elements owing to the fact that their time of transformation is long compared with the age of our planet.

It is of interest to note what an important part the α-particle, which is itself a product of transformation of the natural radioactive bodies, has played in the growth of our knowledge of artificial transmutation. It is to be remembered too that our main source of neutrons for experimental purposes is provided by the bombardment of beryllium with α-particles. The amount of radium available in our laboratories is, however, limited and it was early recognised that if our knowledge of transmutation was to be extended, it was necessary to have a copious supply of fast particles of all kinds for bombarding purposes. It is well known that enormous numbers of protons and deuterons, for example, can be easily produced by the passage of the electric discharge through hydrogen and deuterium (heavy hydrogen). To be effective for transmutation purposes, however, these charged particles must be given a high speed by accelerating them in a strong electric field. This has involved the use of apparatus on an engineering scale to provide voltages as high as one million volts or more and the use of fast pumps to maintain a good vacuum.

A large amount of difficult technical work has been necessary to produce such high D.C. voltages and to find the best methods of applying them to the accelerating system. In Cambridge these high voltages are produced by multiplying the voltage of a transformer by a system of condensers and rectifiers; in the U.S.A. by the use of a novel type of electrostatic generator, first developed by van der Graaf. Prof. Lawrence of the University of California has devised an ingenious instrument called a 'cyclotron' in which the charged particles are automatically accelerated in multiple stages. This involves the use of huge electromagnets and very powerful electric oscillators. By this method, he has succeeded in producing streams of fast particles which have energies as high as the α-particle ejected from radioactive substances. Undoubtedly this type of apparatus will prove of great importance in giving us a supply of much faster particles than we can hope to produce by the more direct methods.

It was at first thought that very high potentials of the order of several million volts would be required to obtain particles to study the transmutation of elements. Here, however, the development of the theory of wave-mechanics came to the aid of the experimenter, for Gamow showed that there was a small chance that comparatively slow bombarding particles might enter a nucleus. This theoretical conclusion has been completely verified by experiment. In the case of a light element like lithium, transformation effects can be readily observed with protons of energy as low

as 20,000 volts. Of course, the amount of transformation increases rapidly with rise of voltage.

The study of the transmutation of elements by using accelerated protons and deuterons as bombarding particles, has given us a wealth of new information. The capture of the proton or deuteron by a nucleus leads in many cases to types of transmutation of unusual interest. For example, the bombardment of the isotope of lithium of mass 7 by protons leads to the formation of a beryllium nucleus of mass 8 with a great excess of energy. This immediately breaks up with two α-particles shot out in nearly opposite directions. When boron 11 is bombarded by protons, a carbon nucleus of mass 12 is formed which breaks up in most cases into three α-particles. The deuteron is in some respects even more effective than the proton as a transmuting agent. When deuterons are used to bombard a compound of deuterium, previously unknown isotopes of hydrogen and of helium of mass 3 are formed, while fast protons and neutrons are liberated. The bombardment of beryllium by very fast deuterons gives rise to a plentiful supply of neutrons. Lawrence has shown that the bombardment of bismuth by very fast deuterons leads to the production of a radioactive bismuth isotope which is identical with the well known natural radioactive product radium E. Many artificial radioactive elements can be produced often in great intensity. For example, the bombardment of common salt by fast deuterons gives rise to a radioactive isotope of sodium. This breaks up with a half period of 15 hours, emitting not only fast β-particles by γ-rays at least as penetrating as those from radium.

It may well be that in course of time such artificial radioactive elements may prove a useful substitute for radium in therapeutic work. By these methods also, such intense sources of neutrons can be produced that special precautions have to be taken for the safety of the operators of the apparatus.

Sufficient I think has been said to illustrate the variety and interest of the transmutations produced by these bombardment methods. It should, however, be pointed out that transmutation in some cases can be effected by transferring energy to a nucleus by means of gamma rays of high quantum energy instead of by a material particle. For example, the deuteron can be broken up into its components, the proton and neutron, by the action of the gamma rays from radium or thorium. As a result of the bombardment of lithium by protons, gamma rays of extraordinarily great quantum energy as high as 17 million volts are strongly emitted. Bothe has recently shown that these high energy rays are able to transmute a number of atoms, neutrons usually being emitted in the process.

Some simple laws appear to hold in all individual transformations so far examined. Nuclear charge is always conserved, and where heavy particles are emitted, so also is energy when account is taken of the equivalence of mass and energy. Certain difficulties arise with regard to the conservation of energy in cases where light positive and negative electrons are emitted during transmutation, and there is still much discussion on this important question.

The study of the transmutation of matter has been extraordinarily fruitful in results of fundamental importance. In addition to the α-particle, it has disclosed to us the existence of those two building units of nuclei, the proton and neutron. It has greatly widened our conception of the varieties of atomic nuclei which can exist in nature. Not only has it led to the discovery of about one hundred new radioactive elements, but also of several stable isotopes of known elements like ^3H, ^3He, ^8Be which had previously been unsuspected. It has greatly extended our knowledge of the ways in which nuclei can be built up and broken down, and has brought to our attention the extraordinary violence of some of the nuclear explosions which occur. The great majority of our elements have been transmuted by the bombardment method and in the case of the light elements which have been most carefully studied a great variety of modes of transmutation have been established.

Rapid progress has been made but much still remains to be done before we can hope to understand the detailed structure and stability of different forms of atomic nuclei and the origin of the elements. I cannot but reflect on the amazing contrast between my first experiment on the transmutation of nitrogen in the University of Man-

chester in 1919 and the large-scale experiments on transmutation which are now in progress in many parts of the world. In the one case, imagine an observer in a dark room with very simple apparatus painfully counting with a microscope a few faint scintillations originating from the bombardment of nitrogen by a source of α-particles. Contarst this with the large scale apparatus now in use for experiments on transmutation in Cambridge. A great hall contains massive and elaborate machinery, rising tier on tier, to give a steady potential of about two million volts. Nearby is the tall accelerating column with a power station on top, protected by great corona shields reminding one of a photograph in the film of Wells' *The Shape of Things to Come.* The intense stream of accelerated particles falls on the target in the room below with thick walls to protect the workers from stray radiation. Here is a band of investigators using complicated electrical devices for counting automatically the multitude of fast particles arising from the transformation of the target element or photographing with an expansion chamber, automatically controlled, the actual tracks of particles from exploding atoms.

To examine the effect of still faster particles, a cyclotron is installed in another large room. The large electromagnet and accessories are surrounded with great water tanks containing boron in solution to protect the workers from the effect of neutrons released in the apparatus. A power station nearby is needed to provide current to excite the electromagnet and the powerful electric oscillators.

Such a comparison illustrates the remarkable changes in the scale of research that have taken place in certain branches of pure science within the last twenty years. Such a development is inevitable, for, as science progresses, important problems arise which can only be solved by the use of large powers and complicated apparatus, requiring the attention of a team of research workers. If rapid progress is to be made, such team work is likely to be a feature of the more elaborate researches in the future. Fortunately there is still plenty of scope for the individual research worker in many experiments of a simpler kind.

The science of Physics now covers such a vast field that it is impossible for any laboratory to provide up-to-date facilities for research in more than a few of its branches. There is a growing tendency in our research laboratories to-day to specialise in those particular branches of Physics in which they are most interested or specially equipped. Such a division of the field of research amongst a number of universities has certain advantages, provided that this subdivision is not carried too far. In general, the universities should be left free as far as possible to develop their own lines of research and encouraged to train young investigators, for it cannot be doubted that vigorous schools of research in pure science are vital to any nation if it wishes to develop effectively the application of science, whether to agriculture, industry or medicine. Since investigations in modern science are sometimes costly, and often require the use of expensive apparatus and large-scale collaboration, it is obviously essential that adequate funds should be available to the universities to cover the cost of such researches.

Conclusion

In this brief survey I have tried to outline the contributions to scientific knowledge made in India, and the needs of the immediate future if science is to play its part in the national welfare. While the study of modern science in India is comparatively recent and naturally much influenced by Western ideas, it is well to recall that India in ancient days was the home of a flourishing indigenous science, which in some respects was in advance of the rest of the world at that time. The study of ancient writings has discovered in recent years the extent and variety of these scientific contributions, which notably advanced the study of arithmetic and geometry. The researches of Sir Prafulla Ray have also brought to light the important advances made in metallurgy and chemistry. May we not hope that this natural aptitude for experimental and abstract science, shown so long ago, is still characteristic of the Indian peoples, and that in the days to come India will again become the home of science, not only as a form of intellectual activity but also as a means of furthering the progress of her peoples.

Are the Himalayas Compensated?

D. N. Wadia

Geological Survey of India.

I. The Rise of the Himalayas

At a period in the geological history of our earth, which to compare earth-history with the known human history since its earliest dawn, would be as recent as the closing years of the Moghul dynasty, the geographical outlines of India were of the haziest description and it was not separated from Eurasia by the present formidable mountain ranges which so effectively barricade it from the west, north and east. One of the most closely established facts of geological science tells us of a sea, which girdled India along its north face through vast aeons of time—a true mediterranean sea which divided the northern continent of Eurasia (known as Angaraland) from a southern continent of more or less uncertain borders, but which united within its compass the present disjointed peninsulas of Africa, Arabia, India and Australia (known to geologists as Gondwanaland). Between the Deccan and the Siberian lowlands as far as the Arctic Ocean, there was then no mountain barrier of any importance, save the stunted and broken chain of the Altaids of Eastern Turkestan; and there then prevailed an oceanway which provided in the beautiful words of the hymn " from Greenland's icy mountains to India's coral strand " an uninterrupted intercourse and migration of marine animals unknown in the world of to-day.

The rise of the Himalayas from the floor of this mediterranean sea is an epic of the geological history of Asia. All the relevant facts of this event are well dated and documented in the rock records of these mountains. But before we refer to this, let us briefly discuss the mechanics of mountain uplift in the dynamics of the earth's crust. It should be realized at the outset that, contrary to our rooted ideas of the strength and rigidity of our *terra firma*, the earth has a mobile crust, sensitive to loads and underloads, to pressures acting from the sides, from the interior of the earth and even from above, *e.g.*, great and abrupt changes of atmospheric pressures. It responds to these forces in a manner which led many early geologists to postulate a hot liquid interior of the earth, fluid through the entire 4000 miles radius and only supporting a cold solid crust of 50 to 100 miles thickness. There are many kinds of earth movements recorded in every part of the globe and definitely registered at the surface—small and large, rapid and slow, local and widespread, secular and periodic. Of these various kinds of earth pulsations, the most significant are the great periodic deformations of the crust which affect long linear belts of the circumference—the mountain-building or orogenic movements. These mountain-building disturbances succeed each other at vast time-intervals and are to some extent cyclical in their recurrence. They are the great epoch-marking events of earth-history and bring about profound re-adjustments of lands and seas and their relative distribution. The most generally accepted view of the origin of mountain-chains is what is known as the geosynclinal theory of mountain-formation. Here I shall quote from a former paper of mine.

"Paradoxical as it may seem, mountains denote the weaker belts of the earth's crust, belts that have been depressed below the sea for long ages and have received enormous deposits of marine sediments belonging to long cycles of geological ages. It is these overloaded, and consequently weakened, zones which respond most to the lateral and tangential earth-pressures which follow the cessation of the sinking process and become folded and elevated into mountain chains. Hence has arisen the well-known principle of geology that where areas of the earth have sunk the deepest, they also rise highest. These sunken and loaded belts are called *geosynclines* in geology, and geosynclines have played a large part in the revolutions of the earth's past geography, stamping upon it the

broader features of the continents, mountains and the ocean-basins. The records preserved in its sedimentary piles reveal the history of the life, deposits, and earth-movements of the various periods in different regions of the earth. During the process of compression of these sunken loaded zones into mountains, the geosynclines are narrowed to from a half to a quarter of their original width; the formation of the Himalaya has, for instance, brought a point in Tibet nearer to a point in Bihar by seventy to eighty miles at least.

Perhaps the largest individual geosyncline on the face of the earth is the one represented by the Himalayan system of mountains—a series of ranges 1,500 miles long and from 150 to 250 miles broad. Geological work of the last few decades in these mountains has proved that, in spite of some local differences, there is an essential unity of structure, composition, and stratigraphy from Kashmir to Assam, which proves clearly that this vast tract of northern India was under the waters of a mediterranean sea—known to geologists as the Tethys—continuously from the end of the Carboniferous period of earth-history to the end of the Eocene.

The thousands of feet of marine sediments laid down on the bed of this sea, from the Upper Carboniferous to the Eocine, with their characteristic entombed fossils indicative of the successive ages of deposits, were subjected to protracted compression during later Tertiary ages, as in a vice, between the two stable continental blocks of peninsular India to the south and the tableland of Tibet to the north. The uplifting of the Tethys floor resulting from this compression, its exposure to atmospheric agents, and the sculpturing of time, have produced the youngest, largest, and highest chain of mountains in the world, a chain that is probably still growing in altitude."*

The above described process of mountain formation is preceded and accompanied by a thickening of the earth's crust along the belts which are to give rise to the future mountain-chain. Also slices and sheets of strata are thrust forward during the process of uplift from the direction of maximum pressure and pulled down to lower levels. These rocks acquire great heat by conduction of the heat of the earth's interior as well as from the radio-activity of the crustal and sub-crustal rocks themselves. The roots of the mountains thus must expand considerably, both in a vertical direction and to a smaller extent laterally and thus help in the elevatory effect of lateral compression from the sides.

Each typical mountain-chain, *e.g.*, the Himalayas, the Alps, Andes, the Caucasus, etc., represents, according to present day conceptions, a squeezed belt of deep oceanic deposits lying between two inflexible rigid blocks of the earth, of the nature distinguished in geology as *horsts*. The primary motive force in this great tangential compression must be gravity, the energy of falling crust-segments in a cooling and contracting planet.

The weakening of the sunken belt of sediments referred to above arises through various understandable causes. The most significant is the increase of earth-temperature with depression. The strata depressed 20,000 feet below the surface in a sinking floor of the sea, as in the roots of a geosyncline would experience a rise of over 400°C. Temperature combined with high pressure weakens rigidity. The ceaseless evolution of thermal energy by the radioactive sediments in a geosynclinal belt is a contributing cause to the rise of the isogeotherms.

It is still a question how far lateral pressures are effective in elevating a mountain chain. According to some geophysicists, the major share in the uplift belongs to direct vertical movement caused by transfer of bodies of the liquid interior, or by changes in the density of the sub-crustal magma.

The rise of the Himalayas from the mediterranean sea-bed was not a single act, but there were 3 distinct and widely separated phases of uplift. The earliest phase was post-Eocene. A few patches of the Eocene Nummulitic limestone, a highly certain land-mark in geological history, are found at Kashmir, Hundes, and several parts of Eastern Tibet, capping the pile of marine sediments that had been growing on the ocean-floor since the Upper Carboniferous. This is the last record left by the Himalayan sea before it vanished. These Eocene rocks now occur at elevations from 15,000 to 20,000 ft. The next upheavals took place at the end of the Miocene epoch, which involved and lifted the sediments laid down by rivers along the flanks of the embryonic mountain-chain into the Middle or Lower Himalaya ranges. The last movement did not commence till after the very end of the Tertiary and involved the foot-

* The Trend-line of the Himalaya—*Himalayan Journal*, Vol. VIII, p. 63, Oxford, 1936.

hills zone of Siwalik deposits, a system of strata as new as the Middle Pleistocene, and containing within its tilted beds some relics of early Man in India. There is a body of competent evidence, both physical and biological, to indicate that parts of the Himalayas have risen at least 5000 ft. since the Middle Pleistocene. Early man thus witnessed the growth of this northern barrier interfering more and more with his migrations and intercourse across the Steppes of Asia. A great ethnic watershed thus came into being early in human history.

Before we pass on to the subject of the static relations of the Himalayas and their physical adjustment with the interior of the earth, let us try to realise the magnitude of this earth-feature that for 26 degrees of meridian presents a wall of 20,000 ft. mean elevation. Standing in the path of the prevalent equatorial wind currents one can easily imagine what dominating influence this chain must have on the water and air circulation of Asia, on its meteorology and physiography, and through these on the distribution of life on the continent. We may mention the most significant instance of this effect. The vast desert tract of Tibet and of the Tarim basin to its north, the latter occupying an area three-fourth the size of the Deccan peninsula and in its geomorphology comparable to our Gangetic basin are some of the most desolate regions of the world. It is a well known fact that these deserts are of recent, in the case of the Tarim depression, of late historic, growth. These once fertile and well-forested regions have been fighting against adverse climatic conditions since the end of the Glacial period; they succeeded in preserving the remnants of their forests and cultivation even to such late age as the early centuries of the Christian era, but have since then steadily succumbed. The increasing desiccation of this area, generally admitted to be in a material way connected with the interposition of the lofty mountain on the south, has had its full toll on the river-system, which, once extensive and well-developed, has decayed and withered to such an extent that the few existing rivers lose themselves entirely in growing sands and surface debris which they are wholly powerless to sweep away. The Kuen Lun glaciers, the survivers of these of the Ice Age, are wasting away their vast reservoirs of ice and are retreating. The perennial north-flowing rivers which they once supported now disappear near the foot of the mountains either in the piedment gravels or in the shifting dunes of Takla Makan, the immense waterless waste of sand that has replaced the once fertile lowlands of Khotan. But the tale is not complete. The small amount of water that does penetrate the Himalayas through its gorges and defiles and reach southern Tibet is turned back to India by the trans-Himalayan affluents of the Indus, Sutlej, Ganges and the Brahmaputra to swell the floods perennially flowing down these noble streams through the plains of northern India. In this manner the Himalayas have protected northern India from the gradual desiccation that has overspread Central Asia from Khorasan in Eastern Persia to Mongolia since early historic times and the desert conditions that inevitably follow desiccation in the heart of a continent.

II. Geophysical and Geodetic Considerations.

ISOSTASY

Mountains, particularly the cores of mountains, after their dissection by the agents of atmospheric denudation, rain, rivers and frost, throw light on the physics of the earth's crust. Their uplift brings to the surface the deeper fundamental rock-complexes and structures, which would otherwise be buried under thousands of metres of rock. Their uprise again, being an important event in geodynamics, requiring redistribution of density and of mass in the interior, present interesting questions of gravity and plumb-line deflection in relation to the surface-relief. It should be mentioned at the outset that geodesy does not regard mountains as mere unadjusted excrescences, as so much extra matter on the earth's surface. If Central Asia, with the high standing Tibetan plateau supporting the Himalayan elevation were extra masses of rock piled on the circumference of a homogeneous earth uniform to the core, the waters of the Indian Ocean would be pulled up a considerable way towards the foot of the Himalayas, extending much above the present heads of the Bay of Bengal or the Arabian Sea. The fact that the sea-level is not appreciably affected,

warped or distorted out of the spheroid form shows that the continents and mountainous portions of the earth's body, in relation to the hollows of the great oceans, are in some sort of adjustment with their bases and are commonly believed to be supported on a dense plastic substratum by a process of flotation, somewhat as ice-caps are supported on the surface of the polar seas. This theory of support of mountains by flotation on a dense medium gives a rational explanation of the existence of what is commonly termed "mountain compensation," and also accounts for the stability of some abnormally abrupt features of earth-relief. *e.g.* the great chain of the Andes on the west coast of South America, rising 20,000 ft. in altitude, rise in front of one of the profoundest deeps of the Pacific. Here the Andeian highlands plunge down to a depth of 26,000 ft. below the ocean level. This view attributes mountain-chains to a lateral compression of the geosynclinal troughs, filled with comparatively lighter sediments, causing a bulge in the crust, both upwards and downwards. The downward protuberance will cause a displacement of the denser substratum, thus providing buoyancy.

That the earth is not homogeneous and uniformly rigid to the core is borne out by the phenomena of earthquakes, vulcanicity, tides, etc. To small periodic forces applied for short durations of time, *e.g.* earthquake waves, the average rigidity of our earth's crust as a whole is twice that of steel. Down to a depth of about 300 miles, the average rigidity of the crust is considerably more than that of steel. But to prolonged extensive pressures, such as those exerted at the roots of mountains or by continental ice-sheets of the magnitude of that covering Greenland (a mass of over a million square miles having a thickness of 3000 ft.), the earth behaves as a plastic body and the surface sinks underneath the load by a viscous flow of the semi-fluid or plastic rocks under the solid crust. The weight of the ice-sheets that covered Scandinavia in the Pleistocene Ice Age depressed that land-area by several meters. This sinking of the coast-line of Norway and Sweden under load of glacial ice and its re-emergence after melting of the ice at the end of the Glacial epoch has produced a number of well-marked strand-lines along the Baltic. These well-marked beach-lines or strand-lines were at first a puzzle but are now without much doubt ascribed to the oscillations of level due to sinking or raising of land under the load of Pleistocene ice or its melting.

Below the cold, rigid crust, the earth seems to have but little strength, to judge from these proofs of its mobility; modern geo-physics regards all crust-deformities, both on a large scale as well as small scale, as essentially the result of the failure of the earth's sub-crust under sufficiently powerful stresses.

India is particularly favourably circumstanced from the study of geophysics and geodesy, the science of investigating the size, shape and structure of large areas of the earth. The crust movements implied in the formation of the Himalayas, the youngest mountains of the world, are juxta-posed against the stable land-mass of the Deccan, one of the most ancient blocks of the earth's shell, which has experienced no folding of the mountain-building type since the dawn of earth history. Measurements of gravity in relation to earth-feature have been carried out by the Survey of India since 1800 and have given some most interesting results. Early in his work (1830) Everest recognised that the Himalayas would exercise a disturbing effect in the triangulation of India, which necessitated the accurate measurement of the arc of the meridian of 78° through the length of India from Cape Comorin to near Mussoorie. A large volume of accurate data from these measurements has been collected, though some of the results are discrepant and are not capable of explanation on existing theories. This is natural, for Northern India is a region of extraordinary tectonic disturbance which has deformed the geoid (the shape or figure of the earth) to such an extent that in no other part of the world has the direction of gravity been found to undergo such abnormal variations as have been detected by the Survey of India in Northern India and by the Russian surveyors north of the Pamirs in Ferghana. According to Sir Sidney Burrard, in no other country in the world does a surface of liquid at rest deviate so much from the horizontal. It was in India that it was discovered that a deficiency of matter underlies the vast pile of superficial matter, the Himalaya; that, on the other

hand, a chain of dense matter runs hidden under the Indo Gangetic plains; and that sea-ward deflections of the pendulum, rather than towards the Ghats, prevail round the coasts of Deccan. These discoveries led to the formulation of the theory of *mountain compensation* in about 1854 by the Rev. J. H. Pratt, Archdeacon of Calcutta, a theory which was subsequently elaborated and expanded into the doctrine of *Isostasy*. This simple hypothesis, which has had a great vogue, particularly in America, implies a certain amount of hydrostatic balance between the different segments of the earth's crust and an adjustment between the surface topographic relief and the arrangement of density in the sub-crust, so that above each region of less density there will be a bulge, while over tracts of greater density there will be a hollow the former will be the continents, plateaus and mountains, the latter the ocean basins. The excess material over portions of the earth above the sea-level will thus be compensated for by a defect of density in the underlying material, the continents and mountains being floated because they are composed of relatively light material; similarly the floor of the ocean will be depressed because it is composed of unusually dense rocky substratum. If an extra load is imposed on any part of the surface, *e.g.* deltas and ice sheets during a glacial epoch, it must sink under it, while regions exposed to prolonged denudation must rise until equilibrium is established. The depth at which isostatic compensation is supposed to be complete is found, in the United States of America, to be about 76 miles. In India it is difficult to arrive at any such definite figure, for isostatic conditions must evidently be different in the Peninsula, a region of high geological antiquity, from those of the extra-Peninsular mountain region, which have undergone very recent orographic movements of the crust. In the former area isostatic balance must obviously be more perfect than in the Himalaya.

Plumb-line and pendulum observations at Dehra Dun have shown that the "topographic deflection," i.e. that due to the calculated visible mass of the Himalaya to the north is 86″, but the true observed deflection is only 31″. For Murree the figures are 45″ and 12″ respectively; while for Kaliana, north of Meerut, which is only 50 miles from the foot of the Himalaya, the observed deflection is only 1″, whereas it ought to be 58″. These observations prove that the Himalayas are largely compensated, though not fully, for the differences between the observed deflections and the theoretical, even under the assumption of isostatic compensation, are too great.

On the Indo-Gangetic plains the deflections are invariably to the south and not towards the Himalaya. This southerly deflection increases till the Lat. 23°N, to the south of which the plumb line deflects again to the north. These discrepant data have been explained by Burrard by assuming that there exists underneath the plains a chain of dense rock, from Orissa north-westwards through Jubblepore to Karachi- an assumption which is fully borne out by the large number of gravity measurements of recent years.

The Indo-Gangetic Trough

At the foot of the Himalayas and parallel with their extension from Hazara to Assam runs the great plains tract of Northern India. These level plains of the Punjab, United Provinces, Bihar and Bengal mark the site of a deep deficiency that is filled up with sands, clay and silt brought down from the mountans by the rivers of the Indus Ganges systems. This hollow or trough, variously estimated as from 3500 to 20,000 ft. deep, is now regarded by Indian geologists as a "fore deep" in front of the Himalayas, a complementary sagging produced in the edge of the Peninsular foreland as it resisted the advancing crustal waves from the north. These two features, therefore, having a common origin, must be considered together. Though filled wth lighter rock- -the alluvium is about 18% less dense than normal rock to such great depth, the gravitative attraction of the Indo-Gangetic plains show no defect of density, on the contrary as mentioned above, the plumb-line in the Gangetic basin is deflected towards the plains and away from the Himalaya. This fact is of the highest significance and although its exact implications are not thoroughly understood, it suggests some kind of correlation between underground distribution of density and surface geological features: at the same time it goes a great way in accounting for the fundamental structural unity of the Himalayas and the Gangetic trough.

ARE THE HIMALAYAS COMPENSTED?

To what extent are the Himalayas compensated? Observations at a large number of gravity stations in the midst of the Himalayas enable us to say that there is a defect of compensation in the outer foot-hills, known as the Sub-Himalayan zone, in other words, this area is undercompensated and one of overload. This defect increases in amount until, according to Oldham, "at some 50 miles from the edge of the hills it reaches an equivalent to an overload of about 2000 ft. of rock. In the interior of the Himalayas, in the central ranges, observations show that at about 140 miles from the edge of the mountains this overload has disappeared and compensation is in excess." These variations in the balance between the topographical and underground compensation, according to the same authority, lend some corroboration to the theory of support of the range by flotation and seems to suggest the rather Gilbertian conclusion that the growth of the support has been more rapid than that of the range above it. The primary problem then becomes not as to how the Himalayas are supported at their actual height, but why they are not even loftier, in other words, the problem is carried one stage further back, from the origin of the range to the origin of its root.*

The question of the origin of mountain-ranges thus acquires a new significance—the primary factor in the production of the range on the surface of the earth is not the formation and elevation of a tract carrying a deep pile of sediments, but the provision of a belt of excess of buoyancy under the range, which provides the motive force; the range itself thus becomes but a secondary phenomenon to the processes at work in the sub-stratum below.

The question "Are the Himalayas compensated?" is thus in a way answered, for compensation is proved to exist. There are, however, differences of opinion as to the why and wherefore of the case; why compensation exists and what circumstances bring it about? Measurements of gravity and deviations from the vertical as carried out by the Geodetic Survey of India during the last 2 decades give some support to the main facts of isostasy, though there are doubts regarding the degree of its completeness and the depth at which it is effective; the theoretical explanation of isostasy is also found to be inadequate in explaining the large anomalies of gravity which prevail in India. These anomalies, both positive and negative, occur even when there are no surface features present to account for them. The "Hidden Chain" of Burrard, a well-marked belt of excess of density traversing the plains from Orissa to Baluchistan is still a mystery. For the main relief features of India, although a considerable degree of compensation does exist, there are serious anomalies between the theoretical (*i.e.* calculated from existing topography) and observed values of the direction and force of gravity which remain to be accounted for. For example, gravimetric surveys have definitely proved belts of underground excess of density and of defects of density in Northern India, which are not represented by any surface deeps or heights. This is fundamentally at variance with the hypothesis of isostasy.

To account for these anomalies, an alternative hypothesis has lately been propounded by Col. Glennie of the Survey of India. It aims to explain the gravity anomalies by assuming a series of bulges or upwarps and troughs or downwarps in the dense layers of rocks lining the sub-crust, at a depth of some 20 miles below the surface. These crustal warps elevate and depress the dense basaltic sub-stratum of the granitic crust, above or below its equilibrium plane and thus create conditions favourable for prolonged erosion in the one area and of accumulation of sediment in the other area. The subject, however, is still in the stage of examination and discussion.

It appears that on the whole India is an area of defective density. Gravity in India is in deficit in spite of all the height, bulk and weight the Himalayas have given to it, and it needs a thick stratum of rock somewhere about 600 ft., spread over the entire surface of the country to counterbalance the defect of mass.*

* R. D. Oldham: *Q. J. G. S.*, Vol. LXXII, p. ix, London 1916. *Mem. G.S.I.*, Vol. XLII, Pt. 2, Calcutta, 1917.

* A lecture delivered at Allahabad on the occasion of the Golden Jubilee of the Allahabad University.

Conditioned Reflexes

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THERE is a belief that the various branches of psychology has made progress just in so far as they have freed themselves from the trammels of of consciousness and introspection. Hunter proposes to scrap the word " psychology " altogether and to substitute the new term " anthroponomy". But no one could be more drastic in the exclusion of conscious events than the German objectivists. They objected, for example, to the use of the term " ear ", because the ear is the organ of hearing. We have, they thought, no right to assume that organisms hear; let us use, they said, the term " phonoreceptor". Similarly, we have no right to assume that an animal sees; let us use the term " photoreceptor ". This behaviouristic spirit early in its career fell in with a powerful ally, namely the doctrine of ' Reflexology ' or the "Conditioned Reflex" which developed independently in Russia. Russian reflexology was the creation of two men Bechterev and Pavlov. The former while collaborating with Spirtov reported experiments on an "artificially associated respiratory motor reflex " in the dog. If cold be suddenly applied to the skin there occurs in dogs (as in ourselves) a well-marked reflex catching of the breath. Bechterev noticed that, if another stimulus is repeatedly applied at the same time as the cold, it will eventually start off the same reflex when given by itself, will in fact act as though it were a substitute for the " natural " stimulus of the reflex. Even before Bechterev's discovery of the " associated reflex " Pavlov had found a similar phenomenon in what he called the " Conditioned reflex." He observed that a dog would secrete saliva, not only when given food, but when presented with a stimulus that was associated with food. The dogs could be trained to salivate at varying periods after the conditioning stimulus (the so-called " trace reflex"), and such astonishing accuracy in the measurement of time was shown that a suitably trained dog would salivate exactly thirty minutes after the stimulus, no reaction being obtained even at the twenty-ninth minute.

This conditioned reflex has gradually become one of the principal methods and working concepts of behaviourism. Indeed, it would seem to afford an almost unlimited field for research. Mateer, using a method devised by Krasnogorski, trained young children to open their mouths to receive a chocolate drop whenever they received a touch on the arm. The children, who ranged in age from three to seven, were also submitted to intelligence tests, and it was found that both the development and the extinction of the conditioned reflex were more rapid in the case of the more intelligent children. On the conative side, Watson has been able to establish conditioned fear reactions to a number of stimuli, as when he showed the child an animal at the same time as a loud voice was made, he found that a fear reaction subsequently occurred at the appearance of this animal. Conditioned reflexes of this kind are very difficult to extinguish, and Watson himself believes that such experiments reveal to us the way in which are formed the irrational phobias of the neurotic. Indeed by many behaviourists the conditioned reflex is regarded as the pattern on which all modifications of conduct are acquired. It is believed that all learning is simply conditioning, and that the conditioned response is the true unit of learned behaviour.

It seems that the conditioned reflex has for the behaviourist taken over the part formerly played by the " association of ideas." Behaviourism, as thus interpreted, is indeed a sort of objective associationism; Watson may perhaps be looked upon as the twentieth-century representative of the position occupied in the nineteenth century by James Mill, and much the same objections may be, and have been, brought against both attempts at the abolition of purpose or activity of mind.

The meaning of a word, is according to this school of thought, nothing but a conditioned response to that word. If, for example, the child reaches toward a bottle, and the word " bottle " is repeated many times in connection with it, then in the course of time saying the word " bottle " will produce in the child the reaching movement; a conditioned response has been established. What the word " bottle " means is the behaviour in reference to the bottle. The associationist view that words arouse simply ideas is altogether abandoned. So the difficulty of the conditioned reflex in explaining the enormous difference of behaviour to the slightly different stimuli—" Your son is dead " and " My son is dead " when destitute of ideas—is hardly met satisfactorily. The theory of the conditioned reflex still deals with the fundamentals of behaviour lower in order, and chooses a point of view which practically presents the matter upside down. In understanding a business we should approach the directors and not plague the office boy or the stenographers. The arrangements in the spinal cord may be easily investigated, but still here the simple process of conditioning is not quite clear. How are we to conceive the effect—namely the watering of the dog's mouth—of the conditioned stimulus (the note)? Is it satisfactory to think of either as the storing in some neural cells of an image of food which bobs up to co-operate when the note is sounded or a channel in the neural pathways opened or enlarged. The cell-doctrine or the drainage theory is no doubt tempting. But the former is altogether exploded and the latter is still popular. The drainage theory is groundless without the theory of lowered resistance of which it is practically an extension. Conditioning is effected by the association of the stimuli—say the sounding of the note and the giving of the food, but surprisingly enough no conditioning takes place if the note is sounded after the food is given. The note is to be sounded before or contemporaneously with the giving of the food for the conditioned act of salivation. But the explanation that the final common path having its synaptic entrance resistance sufficiently lowered gets used to the intruder is not enough. For if we go on sounding the note the resistance should gradually be more decreased and the flow of salivation should be more copious, but on the other hand we observe that the salivation soon ceases altogther, if the note is not from time to time followed by the natural stimulus—the food. So the physiological requirements of the resistance theory are not enough for the conditioning. We find no physiological ground here for the discontinuity of the path opened for salivation at the sounding of the note. Further soundings of the note should have deepened the path, but the path is in fact, instead of being deepened, closed. The synaptic resistance which has been lowered by the mere passage of the impulse should not or cannot be raised by its further passages. Indeed what is lacking here is something mental. The note is changed in meaning, for it being dissociated with the food no longer excites the dog's need for food and consequently the salivation. Thus the reflex theory is indeed bankrupt here. And even Prof. Mcdougall believes in some psychical guidance of the neural discharge when his drainage theory is found inadequate.

Nobel Laureates in Chemistry and Medicine for 1937

Professor Paul Karrer

PAUL Karrer, professor of chemistry, Zurich University, has been awarded the Nobel Prize for chemistry in 1937. He has published a large number of papers dealing with many important problems of organic and bio-chemistry. The most outstanding of his contributions are associated with the chemistry of vitamins, A, B_2 and C, the presence of all of which in our daily diet is absolutely necessary for normal and healthy growth of the body. He isolated pure vitamin A from liver oils of certain sea fish and established its chemical constitution. He synthesized vitamin B_2 (and related compounds) which forms a part of the "yellow oxidizing enzyme" of Warburg. Recently he has turned his attention to the isolation of vitamin E, the antisterility factor, which is present in wheat-germ oil.

Karrer is also widely known for his researches on the natural polyene pigments of vegetable and animal origin, some of which are remarkable from the bio-chemical standpoint. He studied the constitution of β carotene, the colouring matter of carrot, which is transformed into vitamin A in the body. He has also vastly increased our knowledge of the chemical constitution of the pigments present in tomato, saffron, annatto, purple bacteria, crab, lobster, etc. Besides these he has also published a number of papers dealing with the chemistry of polysaccharides, alkaloids and anthocyanins. It is interesting to note that the names of three Nobel Prize winners for 1937 are more or less associated with vitamin C.

P. K. B.

Professor W. N. Haworth

Prof. W. N. Haworth, Director of the Department of Chemistry in the University of Birmingham, has been awarded the Nobel Prize in chemistry for 1937. He is a Davy Medallist of the Royal Society and also Longstaff Medallist of the Chemical Society of London.

After the pioneering researches of Emil Fischer in the chemistry of the sugars, Prof. Haworth's contributions to this fascinating subject bear ample testimony to his experimental skill and resource. Fischer by his study of the hexose unit laid the main foundations of the carbohydrate edifice and Prof. Haworth in collaboration with his distinguished coworkers Dr E. L. Hirst and Dr H. D. K. Drew and many others has not only removed the inconsistencies in the conventional and traditional formulae of sugars, but from a detailed study of the methylated sugars and their derivatives he has adduced conclusive experimental evidence, showing that the normal sugars are related to fyran and the labile sugars are related to firan. He has presented to us the most satisfactory picture of the actual atom model of the sugar units, which is now universally accepted and is now engaged in determining the character of the superstructure Nature builds with these, her chosen units. In Prof. Haworth's own words 'The elucidation of the ring structure of sugars has given a new impetus to constitutional study. The allocation of the hexagon formula to glucose has provided new interpretations of the experimental evidence bearing on the constitution of the polysaccharides.'

Prof. Haworth's work on the constitution of ascorbic acid and its anologues is also of outstanding importance. In 1928 Szent Györgyi isolated from adrenal cortex oranges and cabbages a highly reactive substance named by him hexuronic acid having strong anti-scorbutic properties and this was renamed ascorbic acid by Szent-Györgyi and Haworth which is the same thing as vitamin C. His monumental work in this line bears the stamp of masterly experimental skill and simultaneously

with Karrer he has elucidated the constitution of ascorbic acid and has finally effected its synthesis, although the credit of having described the first synthetic ascorbic acid is due to Reichstein and his collaborators.

D. Chakravarti.

Professor Albert Szent-Gyorgyi

The Nobel Prize in medicine for the year 1937 has been awarded to Professor Albert Szent-Györgyi, Director of the Institute of Medical Chemistry, University of Szeged, Hungary, for his brilliant researches on vitamin C (ascorbic acid) and its therapeutic uses.

While investigating the phenomena of biological oxidation the adrenal cortex attracted his peculiar interest. The observation that freshly cut adrenal cortex rapidly darkens when treated with silver nitrate led him to attempt the isolation of the strongly reducing substance concerned. The effort was crowned with success when a crystalline organic compound of the formula $C_6H_8O_6$ was obtained. The name hexuronic acid was suggested. The identity of this substance with vitamin C (the anti-scorbutic vitamin) was established by Szent-Györgyi in 1932, and the name 'ascorbic acid' was suggested for vitamin C. Large quantities of pure crystalline ascorbic acid were prepared by him later from Hungarian paprika by a relatively simple and elegant method. It was the first time that a vitamin could be isolated in a pure state in such astonishingly large quantities. Facilities were thus provided for the determination of the chemical structure of the vitamin and its final synthesis. The properties of the vitamin and its wide distribution in plants and animals seem to indicate that it plays an important rôle in the complex oxidation reduction processes of the living cell and, apart from the cure and prevention of the deficiency disease scurvy), vitamin C has also been reported to be clinically useful in blood and vascular diseases, local infections, rheumatism, etc. The therapeutic possibilities were also indicated by Szent-Györgyi.

Very recently Szent-Györgyi has reported the existence of a new vitamin --vitamin P belonging to the flavone group of substances. It appears to be effective in curing haemorrhagic diathesis of vascular type. It cured in a striking manner disorders of the permeability of the capillary wall. The existence of vitamin P however has been questioned.

Baidyanath Ghosh.

Redwood Byproducts

One of the largest lumber concerns in the west has accomplished a most spectacular development in the use of the bark of the redwood tree. On the standing tree, the tough, fibrous bark affords protection against fire and other encroachments of time. The Pacific Lumber Co., built a bark-peeling plant at its mill in Scotia, north of San Francisco, together with shredders and driers based on textile industry practice. In processing the product, the bark is put into a shredder to be torn into tiny bits. Then it passes through a series of willowing and condensing machines which remove the dust and solid matter and clean the fibres, reducing them to a soft, fluffy red wool. The product is used as a heat insulator to insulate electric water heaters, in cold storage plants, home construction, air conditioning auxiliaries, and fur vaults. University athletic coaches also are finding the wool useful for running tracks. It is said to furnish a resilient filler under layers of cinders and clay.—

Jour. Frank. Inst.

Notes and News

India's Economic Ills

Presiding over the 21st Session of the Indian Economic Conference held at Hyderabad (Deccan) during the last week of December 1937, Dr P. J. Thomas, Professor of Economics, Madras University, sought in his address to give an answer to the already much discussed problem as to why India, in spite of a large increase in the foreign trade and industrial production in the last seventy years, has not enjoyed any appreciable improvement in the standard of living in the masses. He attributes the reason to two factors: *(a)* inefficient and inadequate production and *(b)* inequitable distribution. "The productive system of the country, said Dr Thomas, has been clogged by an unjust system of distribution. Too large a share of the purchasing power generated in the productive process has been going to the capitalist classes and too small a share into the hands of labourers and small producers. Unfair tenancy conditions, unjust loan transactions and inequitable methods of marketing have been instrumental in bringing about this condition. The result has been persistent under consumption which, in turn, has led to serious under-production and this is the chief malady from which we are suffering in India." "Not only has the baneful economic system", he proceeded, "kept India poor and undeveloped; it has also upset the balance of world economy. Had the purchasing power of the teeming millions of India and China been higher, economic internationalism would have functioned more harmoniously and foodstuffs would not have been destroyed in one part of the world while the other part was hungering for food. In devising the plan for rebuilding our economic system, our national genius and cultural heritage must be taken into account." Dr Thomas concluded:

"Let it be remembered that any rise in the standard of living of the masses in India will not only increase the economic welfare of a fifth of the human race but will also contribute substantially to the well-being of the world as a whole".

Agricultural Research

The Governing Body of the Imperial Council of Agricultural Research which met in Delhi during the second week of December 1937 discussed and renewed in many cases the grants for a number of important schemes already in progress. The renewals include the investigations into the laterite soils which are in progress at the Dacca University and the research in the clay constituent of soil being carried on by Dr J. W. Mukherji at the Calcutta University. Grants for extra assistants for a fruit research scheme in Bihar were renewed. As regards new schemes this year, the Governing Body decided to allocate funds to those schemes which had been commended by Sir John Russell and Dr Wright. For many years an investigation has been proceeding in Calcutta upon Indian drugs. A special grant is now being made to the Madras Veterinary College to test the value of indigenous drugs for curing cattle diseases.

Over twenty representatives of the provinces and States, including Ministers, attended. Among the new schemes sanctioned, according to the 'Associated Press', is the control of tick pests of cattle. This is an insect which attaches itself to cattle and causes loss of condition, resulting in reduced milk yield and frequently causes sores in working bullocks and also carries disease. The method of control is to make cattle walk through a tank containing what is called a "dip", which is a liquid chemical, harmless to cattle but poisonous to the pest. The experiment is being tried in the villages of the Bombay Presidency, the Imperial Council of Agricultural Research and the Bombay Government sharing the cost.

The Governing Body gave its approval to the recommendations of Dr Wright and Sir John Russell and also discussed nearly sixty reports on the progress of research schemes.

Need for a Scientific Vocabulary in Indian Vernaculars

In India, which is called a continent rather than a country, composed of diverse races, speaking

different languages and enjoying different cultures, the need of evolving a common national language is undisputed and is being keenly felt by all and sundry. This need is all the more urgent in view of the dearth of scientific terms and synonyms in the Indian Vernaculars. Of late steps have been taken and efforts made in certain quarters in this direction, and in this connexion must be mentioned the names of the Calcutta University, which is now happily resolved to make the Vernacular the medium of instruction at present up to the Matriculation stage, and the Hindusthani Academy, Allahabad, which have each brought out a booklet containing equivalent scientific terms in Bengali and Hindusthani. These booklets are the results of prolonged deliberations of conferences composed of experienced men who have distinguished themselves in the field of literary persuits or scientific teaching. Once adopted, they will no doubt go a long way to remove the long-felt want for scientific vocabulary in our Vernaculars, in their respective provinces. And we understand that similar steps have either been taken or are being taken in other provinces to evolve out a similar translation of their English equivalents. But what needs to be emphasized in this connexion is that there must be complete co-ordination among these. The vocabulary adopted by one province must be similar to that adopted by another, so that the scientific worker of a particular part may not find it difficult to communicate his thoughts either in writing or in speech to his fellow-workers belonging to a different part with a different language. The terminology current in Bengal must resemble to a great extent to that in the United Provinces, so that when the common national language for India is finally evolved and adopted,there may not be a serious difficulty.

Flowering by Means of Butylene Gas

A patent taken by two research workers of the Department of Agriculture, U. S. A., covers the method of bringing about the flowering of fruit-bearing trees at any time of the year by means of butylene gas. The treatment is carried out in a tent where a concentration of 1 part of butylene in 100,000 parts of air is maintained at a temperature of 15°-37°C, the whole operation lasting one to two hours.

Intravenous Injection of Aspirin for Malaria

For the treatment of Malaria Professor Ascoli of the University of Palermo has introduced daily intravenous injection of aspirin, which reduces the blood contained in the liver—the part where malaria parasites flourish most. This treatment would be effective in the first stages of this malady as well as in chronic cases.

The Death of Prof. H. Molisch

We regret to announce the death of Professor H. Molisch of Vienna on December 9, 1937, at the age of 83. Professor Molisch was regarded as an authority on plant physiology and botany, especially on the chemical side. His chemical tests are accepted as standards all over the world. It may be remembered that at the invitation of Sir J. C. Bose in 1928, Prof. Molisch visited the Bose Research Institute, Calcutta, where he spent a few months studying plant life in this country. He recorded his observations in India in a book published in German in 1929 entitled, *A Naturalist in India*, in which he paid high tributes to Indian scientists and spoke highly of their methods of work.

Dr K. P. Biswas

The degree of Doctor of Science has been awarded to Mr K. P. Biswas, M.A. (Cantab) of the Sibpore Botanical Gardens by the Edinburgh University in recognition of his valuable contributions towards systematic botany in India and Burma.

Dr Biswas had a brilliant academic career and was the recipient of many medals and prizes— for his researches and other activities in the field of learning. During the year 1936-37, while on study leave, he visited the continent and discussed various problems in botany with many leading heads of gardens and horticultural institutions. His paper on 'water and marsh plants in India', read before the Botany Section of the 1937 session of the British Association, was highly appreciated.

Science in Industry

New Use for Tetralin

The Institute of Physical and Chemical Researches in Japan has perfected a process in which tetralin is used for dissolving waste bits of rubber. This on solidification would yield a product highly resistant to abrasion and suitable for fabrication of rubber tyres, beltings, etc. This process will soon be exploited on an industrial scale by a company who have taken the rights of exploiting this process.

Power Alcohol from Molasses

It is reported that the Madras Government is considering the possibilities of manufacturing power alcohol from molasses.

U. P. Schemes for the Development of Industry

The Department of Industries and Commerce of the Government of the United Provinces have sanctioned the following schemes for the development of industries, as previously announced by the Premier in his Budget speech:

Tuitional classes for textile, tanning and wood working industries; improvement of the *gur* industry; improvement of hand spinning; improvement of the glass industry; improvement of the cottage oil industry; survey of cottage and minor industries and establishment of a commercial intelligence section in the Director's office.

About 65 per cent of cane produced in the province is converted into *gur*. The annual output of *gur* in the province is valued at about Rs. 11 crores. The *gur* industry is essentially a cottage industry. The aim of the scheme is to introduce improvements in its various phases that the cultivator may obtain a greater yield, a superior quality and a more favourable price. One demonstrator has been posted to each selected district.

For the improvement of the hand spinning industry, which is being done through the All-India Spinners' Association, it was proposed to conduct experiments for improvement of the spinning wheel; to subsidize hand spinners that they may earn a minimum daily wage of three annas; to distribute spinning wheels and to engage instructors. A sum of Rs. 10,000 is being paid to the association for this work. Arrangements are being made to appoint a glass technologist and to engage him in research work at the Benares Hindu University. The improvement of the cottage oil industry will include a survey of the existing industry; evolving improvements in the existing processes of village crushing, and training educated young men for short periods at the Harcourt Butler Technological Institute, Cawnpore, and setting them up in at least two centres where cheap electricity is available.

Timber Research and Utilization Exhibition

This special Exhibition is being held by the Timber Development Association in conjunction with the Forest Products Research Laboratory, at the Science Museum, South Kensington, to illustrate the methods of investigation of the various natural properties of timber and the practical application of the knowledge thus gained. To most of us timber appears only as a finished product such as furniture or railway sleepers or cricket bats, but before it can be put to any of these uses and to a great many others less known the wood has to pass through many stages of development and preparation from its origin as a tree to its final destiny as an article of more or less permanent use and beauty. Timber to-day fulfils so many purposes that it is in greater demand than ever before; consequently the conservation of existing supplies, new production through afforestation schemes, and research into the growth, properties and uses of wood, are matters not only of commercial but of national concern. In this Exhibition the visitor may study the various aspects of timber production, commencing with the growth, general structure and properties of wood. Illuminated studies of the microscopic structure of different species and their suitability for various purposes are shown, together

with methods of seasoning timber. Seasoning is of the utmost importance; now that the time demanded for "natural" methods of seasoning cannot always be tolerated, much attention is being given to the behaviour of timber under modern accelerated methods. Timber for structural purposes is tested in specially designed machines - these are shown together with modern wood-working machines, and by way of contrast a small range of ancient hand-tools.

Illustrations are given of the specific diseases and insect pests, which attack wood both as a living tree and as a piece of timber, and the requisite antidotes or preservatives. Other sections deal with the fire resistance and thermal qualities of various woods for heat insulation. Of general interest to the visitor are the models and illustrations of modern timber houses and their methods of construction, and an exhibit showing an astonishing array of modern products in more or less everyday use, all of which originate from wood. In connection with the Exhibition a hand book has been compiled by Mr B. Alwyn Jay, M.A., Assistant Technical Director of the Timber Development Association, dealing with the origin, structure, properties, diseases and preservation of timber, its conversion and manufacture, and some aspect of its utilization. The book is intended to be of permanent use in filling the demand for a cheap and concise textbook on Timber. Copies are on sale at the Science Museum, or may be obtained from the publishers, H. M. Stationery Office, price 6d.

The Future and Prospects of Drug Industry

Below we publish the concluding portion of the article, "The Future and Prospects of Drug Industry in India," by Dr B. Mukerji and Dr J. C. Gupta, the preceding part of which appeared in the last issue.

The Future and Prospects of Drug Industry in India

(Continued from the last issue)

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The Present Status of Drug Manufacture in India

Within the last 30 years thanks to the enterprising spirit of some prominent chemists and medical men the drug industry has developed fairly well in India, particularly in the provinces of Bengal and Bombay. Alcoholic extracts of all descriptions -- pharmacopoeial and non-pharmacopoeial- mineral acids, inorganic and organic metallic compounds, proprietary medicines and medicinal specialities, similar to those imported from abroad, have been prepared. Even organotherapeutic preparations like thyroid extracts, suprarenal and pituitary extracts, liver preparations, and biological products like sera, vaccines, and bacteriophages have been produced. The output of these products is, however, at present very small, considering the size of the country and its large population. It is not enough to supply a fraction of the requirements of the people, to say nothing of exporting such preparations to other countries. There is, therefore, an enormous field for further development. But the development must be along well planned and organized lines. During recent years, there are evidences of rapidly-growing, though often spasmodic, interest in the building up of drug-manufacturing industries from the raw materials available in this country. While this is a very hopeful sign deserving of the highest sympathies of all nationally-minded citizens, it cannot be denied that because of lack of proper organization and knowledge of the intricacies of the problems to be faced in such an enterprise, the quality of indigenous products in general is being lowered and deteriorating day by day, being solely left to inexpert people and to ill-equipped laboratories and drug-houses. The evidences produced before the Drugs Enquiry Committee presided over by Col. Chopra bear ample testimony to this statement. The development of

drug industry cannot be done by amateurs and novices, but should be established on scientific basis under expert guidance of chemists and pharamacologists with a good knowledge of the technology of the industry. The days of small industries in drug production of the type of 'cottage' industries are over, and to achieve success and stand the inroads of competition, the drug industry must start out with a sound, well-thought-out policy and with a realization of the needs of the home and the outside market.

Difficulties of Drug Manufacture in India

(1). *Paucity of Reliable Raw Materials*: —One of the chief difficulties which have confronted the manufacturing chemists and pharamaceutists in India for some time and which are still unsolved, is the question of procuring reliable raw materials of standard quality. India possesses vast resources of medicinal plants but the sources of supply have not been fully explored. There is no reliable organization in India for the collection of drugs in proper manner with adequate arrangements for drying and storing. Except for a small number of crude drugs which are available from the Kashmir State Forest Department, the trade in crude drugs is mostly carried on by private individuals and middlemen who, partly due to their ignorance of the subject and partly due to the want of any kind of control on the quality of drugs, deal with adulterated and inferior quality of drugs. Crude drugs imported in India from foreign countries are also no better, and quite often inactive and worthless stuff has been shipped to India. Consequently a manufacturer, who has to procure the proper quality of raw materials, has to be very careful and has to, in his own interest, resort to an elaborate examination before accepting a consignment. For this purpose, a properly equipped laboratory and a large staff of trained chemists have to be maintained. This is an expensive item and materially adds to the cost of manufacture.

(2). *Transportation Charges on Drugs*: This forms another very heavy item and militates against the use of raw materials growing in different places in the country. It sometimes happens that prices of some drugs grown in India are cheaper when purchased from the London market. Strychnos nux vomica is a case in point. Nux vomica seeds are sold in Orissa market at Rs 1-4-0 per maund of 105 lbs., delivered washed and dried at the buyer's godown. These very seeds used to be sold in Calcutta at Rs 5 per maund of 82 lbs. due to high transportation charges by railways. The European manufacturers, however, can get the same thing at half the Calcutta price because the shipping companies carry this commodity as ballast at very low freight, and often it is possible to get a quotation from English stockists for supply in Calcutta of nux vomica seeds at Rs 2-8/- to Rs 3 per maund. If a special reduced railway freight rate is allowed for drugs required for *bonafide* manufacturing purposes in India from the centres of production to places of manufacture, this problem can be easily solved.

(3). *Excise regulations*: Manufacturers are greatly handicapped now due to differences in the provincial excise regulations. While it is not our purpose here to go into details regarding the intricacies involved in this question, it is impartant to point out that this is a source of financial losses to many drug manufacturing concerns. The inter-provincial movement of spirituous medicines from Bengal to Bombay and Madras, for example, is beset with difficulties and inconveniences due to excise restrictions at the provincial boundaries. The imported spirituous preparations of the same type on the other hand, can be sent unhampered anywhere and everywhere in India. Further, all research and analytical works carried out by private manufacturers have to be performed with duty paid spirit. The same statement holds good in the case of alcohol used for the manufacture of alkaloids and for other extraction purposes. These items naturally add to the cost of the finished products issued from the indigenous drug-manufacturing houses.

(4). *Lack of Machinery for Drug Manufacture*: Another important difficulty in starting drug manufacturing industry in this country arises from the lack of information regarding designing of plants for various industries. There is at present no department of chemical engineering in any university in this country, which can successfully undertake the designing and running of commercial plants suitable for the manufacture of drugs. Practically all the machinery needed for modern drug production, beginning from the pill-making machine to ordinary percolators, is imported from abroad. This means a

considerable outlay of money and a very large over-head expense to local business organizations.

It is not possible to deal with the difficulties in an article of this size. Only the important difficulties which are present are mentioned here so that the prospective manufacturers may take stock of the situation and try to overcome them as far as it lies within their power. Some of these can be easily remedied while others will probably take several years and might require Government intervention for their successful solution. We do not however consider that these difficulties are of such magnitude that they should be insuperable barriers to the development of drug industry in India.

Development of Allied Industries

The drug industry today is so intimately related to chemical industries and toilet and perfumery industries that proper emphasis should be given to a consideration of these aspects in any well-planned scheme for its development. In fact, we belong to the group who believe that unless the manufacture of these allied products is developed along with the manufacture of medicinal drugs, the latter cannot attain any remarkable success. A few concrete instances in this connection would serve to illustrate the point at issue. Thus, for the manufacture of galenicals, refined chemicals, alkaloids, etc., extensive use of solvents is required. With the exception of alcohol, most of the solvents *e.g.*, chloroform, ether, benzene, acetone, etc., have to be imported from other countries and a high price has to be paid for them. Alcohol can be and has been produced in India from molasses imported chiefly from Java, but the price is still high enough to militate against its free and unrestricted use. With the present slump in the sugarcane industries all over India, alcohol from Indian molasses could be produced at a very much cheaper rate than before. Benzene could be manufactured from coal which is fairly abundant in our country. The present price is nearly three times the price of benzene in England. Acetone is prepared from wood shavings and saw dust, and these raw materials are available in abundance in the country. Enormous quantities of glycerine are being thrown away in the form of soap washlye from soap factories in India. If this glycerine is recovered, it will not only be a help to the drug-manufacturing industry but will also cheapen the price of Indian soap. Further, glycerine is also needed in the manufacture of many explosives and this will indirectly help in the defence of the country. Large quantities of lactose could be easily made from maunds of 'chhana' water containing milk sugar which is thrown away every day in Bowbazar and in Sealdah. Caustic soda is one of the most important raw materials for a great many industries. If its production is undertaken by drug manufacturing firms, it is sure to be a profitable proposition. In the production of caustic soda, bleaching powder, hydrochloric acid and liquid chlorine would be obtained. Bleaching powder is in great demand in textile factories and the chlorine may be utilized in chlorinating benzene which, as has been already pointed out, could be easily obtained from coal tar. The chlorobenzene will give us phenol, a very important product in the manufacture of liquid disinfectants. Similarly, sulphuric acid is such an important thing in medicinal and chemical industries that it should be one of the chief items to be considered in a large scale drug-manufacturing industry. Camphor to the value of about Rs 25 lakhs is imported every year into India. India has no good source of camphor but with the modern development of the method for preparing synthetic camphor, it could be produced economically from turpentine which is being produced in fairly large quantities in the United Provinces. Indian magnesite is available in large quantities in the Salem District of the Madras Presidency and Magnesium Sulphate can be easily produced from this source in India. These few instances would show how important it is to develop allied chemical industries along with any scheme for the development of drug industry in this country. The same remark applies to the perfumery and toilet industries in all their various phases. Essential oils by improved processes could be obtained from raw materials like Rose, citronella grass, etc., in India or Ceylon. It is gratifying to note that attention has already been directed to this side, but more is required to develop the basic industries.

Promotion of Drug Research

Side by side with the development of chemical and allied industries, a modern drug manufacturing concern must be prepared to set apart a portion of

their capital outlay to promote the establishment of a scientific and research unit. Without a fully equipped technical laboratory where well trained botanists, chemists, bacteriologists, pharmacologists, etc., will have opportunity to carry on investigations on different aspects of the problem of drug production, it will be futile to attempt to initiate a drug-manufacturing industry in India at the present moment. Modern medicine and therapeutics are progressing rapidly, and an industry which ultimately aims to supply the needs and requirements of such scientific practices cannot afford to be backward and undergo the risk of being wiped out sooner or later. In India, the capitalists and industrialists are largely ignorant of the role of science in industry and are apt to think any expenditure on scientific and research projects as unjustified and unnecessary. This is in sharp contrast to the attitude of western manufacturers and industrialists, who do not hesitate to spend a decent portion of the capital on this head alone. Scientific research and development are really the pivots on which drug industry or any other industry, for that matter, should stand in modern times. A visit to the research laboratories of some of the progressive drug and chemical manufacturing concerns in America, England, Germany, etc., cannot fail to impress anyone of the supreme importance of money being spent in this direction. This expenditure usually pays a large dividend in years to come. Thus, the Bayer-Meister Lucius Co., in Germany spent several thousand pounds for nearly 10 years for developing a synthetic antimalarial remedy of the type of quinine. Now their researches have borne fruit, and their scientific investigators have produced 'Atebrin' and 'plasmochin.' It will now be easy for them to realize ten times the money spent on this score. There are many other examples of this nature which show beyond doubt the advisability of maintaining a scientific staff and up to date technical laboratories in drug manufacturing concerns. If such elaborate arrangements are not possible immediately, some of the already existing educational institutions in the country might be approached for advice and help. Research scholarships and fellowships may be endowed by particular firms for carrying on investigation pertaining to their special fields of enquiry, under the guidance of workers of repute in the universities or other educational institutions. This practice is largely resorted to in America and there are now departments in various institutes for bringing about such contacts between university workers and industrial concerns. Very little attention has so far been paid in this direction in India but it is never too late to mend.

The Future and Prospects

If the capital and other things are forthcoming, there seems to be no difficulty to develop the drug industry on sound lines which can compare very favourably with any of the big organizations in the western countries. There is no dearth of qualified chemists, pharmacologists, and chemical engineers in this country who can undertake the responsibility of building up such an organization, provided they go through a period of probation under the guidance of expert technicians. A few firms are no doubt doing creditable work, but the field is enormous and many such firms can exist and prosper. The present time is the most opportune for the initiation of bigger and better drug manufacturing industries as the Government of India have recently taken definite steps towards the standardization of drugs in India, and intend to tighten up the control over the manufacture of spurious and low-grade drugs. By checking unfair competition from small ill equipped firms which have grown up recently like mushroom in all parts of India and who do not stop at producing drugs of cheap and inferior quality, it will stimulate all ethical drug manufacturing firms and thus the drug industry generally. If the drug industry is developed on sound and ethical lines, manned by experts who know their job well and who are honest and trustworthy, there seems every reason to hope that it will meet with great success. The new industries will help economic progress by utilizing the raw materials produced in the country, and will bring medicinal drugs within the reach of the masses in India whose economic conditions are very low. It will not only bring large profits to those who put capital into it but will throw open avenues of employment to a very large number of educated Indian youths. The condition in this country is so bad that our youngmen coming out of schools and colleges cannot find any career in life, and the young energies are being dissipated. We need more industries at this time to widen the base of our economic condition, to increase the resources, and to raise the standard of living.*

Based on a lecture at the Rotary Club, Calcutta.

Research Notes

The Return of Radio Waves from the Middle Atmosphere

Recent observations have now established beyond doubt the existence of sustained stratified electrification much below the Kennelly-Heaviside E layer. The topmost of these layers called the D-layer is situated at an average equivalent height of 55 km. In 1927 Appleton remarked: " another region of ionization (D-layer) is formed below the Kennelly-Heaviside layer, which while causing attenuation of the waves, does not materially affect the height at which they are deviated. Occasionally " reflected " waves are detected from this layer...... It is suggested that layer D is the same as the ozone discovered by Lindemann and Dobson." Appleton & Barnett (*Proc. Roy. Soc.* A. 113) followed the wavelength-change technique and sometimes the equivalent height corresponded to a smaller number of interference fringes and was equal to 60 km. In 1935 Mitra & Shyam gave evidence of echoes from an equivalent height of about 55 km. (*Nature, 135*, 1935 and *Ind. Jour. Physics, 10*, 13, 1936). Besides these echoes which are of infrequent occurrence they adduced another evidence in support of the existence in the day time of an ionospheric region at this height. They found that during the day there is a frequency band which is reflected from the E-region. The upper limit of the frequency band is due to penetration of the E-layer and the lower limit is due to the absorption by the D layer. The D-layer is now regarded as the non-deviating absorbing ' tail ' of the E-region, (*vide*, Farmer & Ratcliffe, *Proc. Roy. Soc.* A. 151, 1935). Suggestions of the return of very low frequency waves from a level of about 75 km. were obtained by Hollingworth in 1926. It was Mitra & Bhar (*Science & Culture*, Vol. 1, June 1936) who for the first time observed in Calcutta echoes from heights much below 55 km. This new region which is quite distinct from the D-region has been called " C " region by Mitra. This region was later corroborated by Colwell & Friend at Morgantown (U.S.A.) (*Nature, 137*, 782, 1936) and by Watson Watt, Bainbridge Bell, Wilkins and Bowen at Orfordness (England) (*Nature, 137*, 866, 1936). G. Goubau of Munich also obtained evidence of the return of radio waves from the C region. Rakshit & Bhar (*Nature, 138*, 283, 1936) have published results showing the structure of the C-region (C_1 at a height of 55 km., C_2 at 20-30 km. and C_3 at a height less than 15 km.).

Watson Watt, Wilkins and Bowen (*Proc. Roy. Soc.* A. 161, 1937, p. 181) have obtained evidence of strata persisting without substantial change of level for several days at such heights as 8.5, 9.3, 10.3, 10.75 and 13.5 km with reflection coefficients of the order of 0.7, giving measurable echoes up to the 10th order beyond which the echoes cannot be distinguished. This region has been quasi humorously called by them the Z region. It is now established that these lower layers are not of ephemeral and fugitive concentrations although for months together such layers may not exist.

The only theory put forward to explain the formation of the C region ionization is by Bowen (*vide* Appendix of paper by Watt, Wilkins & Bowen, *Proc. Roy. Soc.* A. 161, 1937) who associates it with thunderstorms. Following Wilson it is stated that the electrons produced in the intense fields of thunder clouds are accelerated upwards and then bent back towards the ground by the action of the earth's magnetic field. Bowen has constructed trajectories of electrons of different energies projected upwards from a storm. It is found that particles of initial energy less than 2×10^9 V fail to reach the ground and are absorbed in a region between the ground and a height of 20 km., at distances up to 150 km. from the storm centre. This region in which trajectories end is one of intense ionization and is the suggested cause of C-region ionization.

S. R. Khastgir

RESEARCH NOTES

Magnetic Moment of the Proton

The magnetic moment of the proton, the nucleus of hydrogen, has long exercised the mind of physicists. If we suppose that the magnetism in protons arises from the same cause (rotation round an axis fixed in itself) as in the case of electrons, the magnetic moment of the proton ought to be $\frac{1}{1845}$ times less than that of the electron, 1845 being the ratio of the mass of the proton to that of the electron. Some years ago, Stern in Germany shewed experimentally that the moment was $2\frac{1}{2}$ times larger. The result is a challenge to accepted origins of magnetism, and was in need of verification. Stern could not give the finishing touch to the experiment, as he was bundled out of Germany. In America, he was enabled to repeat the experiment.

In a paper recently published in the *Physical Review*, he again confirms his old result. The magnetic moment is found to be 2.46 times higher than the theoretical value. This result is of fundamental importance and necessities a reorientation of our views regarding the origin of magnetic moment in nuclear particle.

Circulation of Phosphorus in Body

The atoms of each element taken up with the food or by the respiration process have an average time which they spend in the body. It had been found by Hevesy and Hofer, by using heavy Hydrogen as indicator, that the average time that a molecule of water spends within the human body is about a fortnight. Hahn, Hevesy and Lundsgaard (*Biochem J., 31*, 1705, 1937) describe experiments by which they have determined the average time that phosphorus spends in the animal body. Radio-active phosphorus, prepared from sulphur by neutron bombardment was administered to a rabbit by subcutaneous injection in the form of Na Phosphate. Faeces and urine excreted for 27 days were collected and their phosphorus content estimated. After 27 days the animal was killed and the phosphorus content of the different organs estimated. The normal phosphorus was estimated by the colorimetric triation method of Fiske and Subbarow while the radioactive P content was estimated by the Geiger Counter. From the results of their experiment it is found that the average time a P atom spends in the body is 30 days. Within 27 days 45 % of the P given was excreted through the kidneys and 11.5 % through the bowels. The comparatively long average time of a fortnight spent by a water molecule in the body was explained by the fact that the water taken is diluted by the large amount of water present in the body. In case of phosphorus also, the long average life of the atoms taken with food is due to dilution of the P atoms taken by those present in the organism.

H. N. B.

Blood Groups of Veddahs

W. C. O. Hill of the Anatomy Department of the Colombo Medical College has published in *Nature*, September 25, 1937 (p. 548, Vol. 40) an article on "Blood Groups of Veddahs". The blood samples of the Veddahs were independently examined by him and by the staff of the Pathology Department, General Hospital, Colombo. The results were identical in all cases. He examined only 5 samples of blood. All were males and three samples from Bintenne, one from Dalbane and the other from Bulugahadena locality. On testing the sera he found that 60% belongs to group O and 40% to B.

University and Academy News

Royal Asiatic Society of Bengal

An Ordinary Monthly Meeting of the Royal Asiatic Society of Bengal was held on Monday, the 6th December, 1937, at 5 30 p.m.

The following candidates have been elected Ordinary Members during the recess months, under Rule 7: (1) Jyotirmaya Ghosh, M.A. (Cal.), Ph.D. (Edin.), F.N.I., Professor of Mathematics, Presidency College, Calcutta; (2) Narayan Chandra Bhattacharyya, M.Sc., Vice-Chairman, Birnagar Municipality, P.O. Birnagar, Dt. Nadia; (3) Erdmann Count Podewils Dürniz, Consul-General for Germany, Calcutta; (4) Hulaschand Jain Sarawgi, Shillong; (5) Abdul Halim, M.A., Lecturer in History, Muslim University, Aligarh.

The following candiate was balloted for as an Ordinary Member: Ramananda Chowdhury, B.A., Dhubri, Assam.

The following paper was read:

(1) Charu Chandra Das-Gupta. Bibliography of ancient Indian terracotta Figurines.

The present paper is the first attempt to give a complete bibliography of ancient Indian terracotta figurines. In the bibliographical section 175 articles, alphabetically arranged according to the authors' names, have been briefly summarized with reference to find-spot, age, description and other important details. Three indexes dealing with author, find-spot, subject and geography have been added.

The following exhibit was shown and commented upon:-

Chintaharan Chakravarti. Manuscripts of a Tantra Work giving *inter alia* the family History of the royal Patron of the Author.

The following communications were made:

(1) L. S. Dugin.--Possibilities of the Persian Quatrain.

A consideration of the variations in the metre, mathematically treated, with literary illustrations.

(2) John van Manen.--The study of Heraclitus.

The study is of the greatest interest mainly from two points of view. Firstly, that of the intrinsic value of the sayings. Secondly, that of the illuminating lesson afforded by philology grappling with an obscure problem.

National Academy of Sciences, India

A meeting of the National Academy of Sciences India, was held on the 18th December, 1937, in the Muir College Buildings, Allahabad. Prof. B Sahni, F.R.S. President of the Academy, was in the chair.

The following members of the Academy were duly elected as Fellows of the Academy:

(1) Dr G. R. Toshniwal, D.Sc., Allahabad University; (2) Dr P. K. Sen Gupta, D.Sc., Rajaram College, Kolhapur, (Bombay); (3) Dr Rajnath, Ph.D., Benares Hindu University; and (4) Dr A. B. Misra, D.Sc., D.Phil. (Oxon), Benares Hindu University.

The following papers were read and discussed:

(1) Ionization in the F layer before sunrise by K. B. Mathur, Allahabad University, Allahabad

(2) Action of Para-toluene-sulphony chloride on Phenols containing azo grounds by A. B. Sen, Lucknow University.

Education Minister's Gold Medal

The National Academy of Sciences, India, is grateful to the Hon'ble Mr. Pearey Lal Sharma, M.A., LL.B., Minister of Education, United Provinces, for the very keen interest he has evinced in the affairs of the Academy by kindly agreeing to continue the award of the Education Minister's Gold Medal for the best research paper published in the *Proceedings* of the National Academy of

Sciences, India. The subject in which the medal will be awarded this year is Mathematics including Astronomy.

Indian Chemical Society

An ordinary meeting of the Indian Chemical Society was held on Friday, the 19th of November, 1937, at the Chemistry Lecture Theatre, University College of Science, Calcutta, with Dr P. C. Mitter in the chair.

The following condolence resolutions were passed:—

"That the Indian Chemical Society places on record its sense of sorrow and loss at the premature death of Mr. Kali Kumar Kumar, a foundation Fellow of the Society and offers its deep condolence to the bereaved family."

"That the Fellows of the Indian Chemical Society place on record their sense of sorrow and loss at the death of Lord Rutherford of Nelson and offer their deep condolence to the bereaved family."

The following gentlemen were admitted as Fellows of the Society, their subscriptions having been received for the first time.

(1) Sailesh Chandra Sen, M.Sc., (Pusa); (2) Sardar Doghar Singh, (Travancore); (3) Dr A. N Ghei, M.B., B.S., D.T.M., D.P.H., R.C.P. & S., (Lahore); (4) M. Raman Nayar, M.A., A.I.I.Sc., (Lucknow); (5) N. N. Pramanik, M.Sc., Ph.D., (Shahjahanpur); (6) N. K. Brahmachari, B.Sc., (Calcutta).

The following gentlemen were elected as Fellows, Dr. S. G. Chaudhury and Mr. H. N. Das Gupta acting as scrutators.

(1) K. R. Natarajan, M. Sc., (Madras); (2) C. A. Rothenheim, (Bombay); (3) S. S. Chowlagi, B.Sc., (Bombay).

The Chairman announced the following nominations of the office-bearers made by the Council for election at the next Annual General Meeting

Vice-Presidents: —Dr B. B. Dey and Dr J. N. Mukherjee.

Hony. Secretary: —Dr B. C. Guha.

Hony. Treasurer:—Dr P. Neogi.

The Chairman announced that the Council has provisionally fixed the 5th of January, 1938 as the date for holding the next Annual General Meeting of the Society in Calcutta at 3 p.m. in the Chemistry Section meeting room of the Indian Science Congress.

Dr S N Ganguly delivered a lecture entitled "Biochemical studies on snake venoms"

Mr P. Ray, Dr B. N. Ghosh, Mr. S. S. De, Dr B. C. Guha and others joined the discussion.

The Electric Gage

A very useful explanation, for informative as well as practical purposes, is that of the electric gage by C M. Hathaway and E. S. Lee in *Mechanical Engineering*, Vol. 59, No. 9. The paper is to be presented at a meeting of the American Society of Mechanical Engineers. An electric gage is a device for measuring linear dimensions or displacement by electricity and particularly for accurately measuring either small dimensions or small variations in larger dimensions. Displacements as small as 0.00001 in. or even 0.000001 in. can be read on an electric indicating instrument. Mechanical amplification ratio can be made as high as 10,000 or 100,000 or even higher if desired. It is fundamentally a device by which an electric current is controlled or modulated according to the relative position of two of its parts. This relationship between current and displacement can be brought about in several ways. Variations in resistance, capacitance, inductance, or wave form can be produced by variations in linear dimensions and these can be measured by variations in an electric current.

—*Jour: Frank. Inst.*

Letters to the Editor

A Study of the Specific Nature of Promoter Effect upon a Nickel Catalyst using as Reactants, Water Vapour and equal volumes of Carbon Monoxide and Hydrogen

(a) Apart from methane formation sugar-carbon-nickel catalyst containing thoria and ceria or alumina accelerates reactions

$$C + H_2O \rightleftharpoons CO + H_2 \text{ and}$$

$$C + 2H_2O \rightleftharpoons CO_2 + 2H_2$$

but with potassium carbonate the reaction

$$2CO \rightleftharpoons C + CO_2$$

is promoted, showing the specific nature of these promoters.

(b) A nickel catalyst containing a mixture of 99% thoria and 1% ceria as promoter yields a highly steady and efficient surface for reactions.

$$CO + H_2O \rightleftharpoons CO_2 + H_2,$$

$$2CO + 2H_2 \rightleftharpoons CH_4 + CO_2$$

and most probably for the reaction

$$CO + 3H_2 \rightleftharpoons CH_4 + H_2O \text{ as well}$$

(c) The reduction of nickel catalyst at a temperature of 300°C. is incomplete when prepared from a very pure sample of nickel acetate. Addition of small quantity of a mixture of cerium nitrate and ammonium vanadate or of cerium nitrate and chromium acetate to the nickel acetate helps in bringing about a more thorough reduction.

Thus catalysis of the reaction

$$2CO + 2H_2 \rightleftharpoons CO_2 + CH_4$$

is indirectly helped by them. Whether there is any direct beneficial effect cannot be said at this stage.

(d) The reduction of nickel catalyst at 3000°C prepared from Merck's nickel nitrate is more thorough when mixed with thorium and cerium nitrates (thoria 99% and ceria 1%).

Thus in this case thoria and ceria mixture also helps the catalysis of reactions

$$2CO + 2H_2 \rightleftharpoons CO_2 + CH_4 \text{ and}$$

$$CO + H_2O \rightleftharpoons CO_2 + H_2$$

indirectly by making the reduction of nickel more complete.

In this case it has also been seen that they together (i) increase the number of properly oriented nickel particles of medium activity (ii) decrease the number of very active particles (iii) stop granule formation on the pumice surface and clogging of the pores in pumice, (iv) stop peeling off of nickel particles from the pumice surface and (v) prevent sintering.

(e) Nickel catalysts with or without promoters while simultaneously catalysing reactions.

$$2CO + 2H_2 \rightleftharpoons CO_2 + CH_4 \text{ and}$$

$$CO + H_2O \rightleftharpoons CO_2 + H_2$$

at 400-450 C were found to adsorb a considerable quantity of carbon dioxide.

Chemical Laboratory, University of Dacca. 15.11.37. — K. M. Chakravarty.

Further Observations on the Probable Role of Carotene in Metabolism of Fats

In a previous note[1] it has been reported that the Reichert values, iodine numbers, carotene and vitamin-A contents of butter fats undergo a seasonal variation most markedly during the autumn and the winter. Thus, out of 41 samples of butter fats analysed during the autumn of 1936 (August to October), 33 samples gave Reichert values below the standard of 24 and the remaining 8 samples gave values above 24 but below the figure of 27. In the case of butter fats, giving the higher Reichert values, it has been found from enquiries made that the cows responsible for these butter fats mainly lived upon the green leaves of water-hyacinth. Samples collected during the months of November, December, January and February (53 in number) gave markedly different results. Thus out of the 53 samples, only 4 gave a Reichert value below the standard of 24 whilst the rest (49 in number) varied from 24 to 29.2 The Iodine numbers also are comparatively higher during the winter than in autumn. Marked variations have also been observed in the carotene and vitamin-A contents of the butter fats during the two seasons. Thus during the autumn, both the carotene and vitamin-A contents of the butter fats are decidedly low. The carotene contents vary from 0 to 5.6 Y.U. and vitamin-A from 1.2 to 5.6 B.U. per gramme of the butter fat whilst during the winter, the carotene values vary from 1.4 to 8.8 Y.U. and vitamin-A from 4.4 to 12.2 B.U. In fact the Reichert and Iodine values during the autumn and winter seasons form two different series, the Reichert and Iodine figures for the winter being both higher than the figures for the autumn.

In many cases, the Reichert value varies inversely as the Iodine number but this is not always true. From a careful study of the data, it will be seen that this is only true when the carotene content is high and vitamin-A content is low or when the carotene content is low but the vitamin-A content is high; but when both the carotene and the Vitamin:A contents are both high figures, (as during the winter) the Reichert and Iodine values are also comparatively high figures. These results show that there might be some relationship between the carotene and the Reichert value on the one hand and Vitamin:A and Iodine number on the other. It therefore occurred to the author that the lipochrome pigment carotene might play some part in the oxidation and desaturation of the fatty acids. The suspicion was found to be true by actual feed-

ing experiments on two healthy cows of the native stock with rations containing different amounts of carotene.

Thus as one of the cows (aged 4 years 6 months, body weight about 800 lbs, period of lactation about 3 months) was given a ration containing less amount of grass and higher amount of straw, carotene contents of the butter fats gradually diminished and with it, also the Reichert values. The vitamin-A content, however, practically remained the same. But as the cow was again given larger and larger amounts of grass in comparison with straw-chops, the carotene content of the butter fats increased to 5.4 Y.U. per gramme in the 7th week. The Reichert value also increased to 26.8 from a value of 21.8, in the 4th and 5th weeks.

With cow No.2 (approximately of the same age, body weight and period of lactation as cow No.1) reverse has occurred. With the gradual increase in the amounts of grass from the 2nd week the Carotene and Vitamin-A contents of the butter-fats both increased. In the 5th week, the carotene has increased from 3.6 Y.U. in the 1st week to 7.5 Y.U. in the 6th week. The Reichert value has also increased from 26.6 in the 1st week to 29.4 in the 5th week. With diminishing amount of grass in the total roughage from the 6th week, the Carotene content gradually lowered down and with it also the Reichert value (from 29.4 to 26.6 in the 8th week). It will be noticed that the Iodine value almost ran parallel with the Reichert values which justified the hypothesis suggested in this paper, viz., when both the Carotene and Vitamin-A contents are high, the Reichert and Iodine values are also higher figures.

The experiments with red palm oil, gave similar results. Thus in the depletion period, when the cow was only on straw and concentrates, the butter-fats gave the following values:—R. M. value 26.8; Iodine value 33.6; Carotene content 3.8 Y.U. per gramme; and Vitamin-A content 7.6 B.U. per gramme. When the cow was given 4 ounces of red palm oil daily (Malayan variety containing 56.8 mg. of Carotene per 100 gm. of the oil), the Reichert value increased from 26.8 to 28.2, the Iodine number also increased from 33.6 to 36.6, the Carotene from 3.8 Y.U. to 6.8 Y.U, and the Vitamin-A increased from 7.6 B.U. to 10.4 B.U. At the end of the 2nd week as the cow was given 8 ounces of red palm oil daily, the Reichert value exhibited a further increase viz., from 28.2 to 29.1 and the Iodine value from 36.6 to 37.4, Carotene from 6.8 to 10.1 and the Vitamin-A content from 10.4 to 14.8. On return to the normal basal diet at the end of the 3rd week, all the values gradually returned to the normal, most markedly the Carotene and Vitamin-A contents. The Iodine value rather slightly increased whilst the Reichert value diminished from 29.1 c.c. in the 4th week to 28.4 c.c. in the 5th week.

The above results are highly suggestive and demonstrate that the lipochrome pigment Carotene might play some part in the oxidation and desaturation of the fatty acids. There is no fixed time for calving in Vikrampur. The cows are generally calved in such a way that the milk output of each dairy does not vary enormously from the normal output. The effect of the period of lactation on the Reichert value might thereby be considerably minimized. The Reichert values obtained therefore show the effect of the climate and the Carotene content of the ration. But the comparatively high Reichert and Iodine values obtained during the winter are coincident with the high Carotene content of the grass during winter in spite of the fact that the cold temperature of the winter had an adverse effect on the Reichert values of the butter-fats. The results obtained by the author clearly demonstrate the effect of Carotene as against both the adverse influences of the period of lactation and the low temperature of the winter. The cow which was much advanced in its period of lactation during November should give butter-fats of much low Reichert values but contrary to expectation, comparatively higher Reichert and Iodine values have been obtained. This can only be explained by the probable role of Carotene in the oxidation and desaturation of the fatty acids. Actual feeding experiments on cows substantiate the theory proposed.

It must be admitted however that the actual mechanism of the oxidation and desaturation processes carried out by the pigment are not clearly understood. It might be that the Carotene acts as a carrier of oxygen in the processes of oxidation of the fatty acids or the oxidation of the fatty acids in Vivo by Carotene may be a case of induced oxidation. In the process of desaturation, Carotene might play the role of a hydrogen acceptor. In fact we know that Carotene can form both oxygenated and hydrogenated products. Euler and his school consider that Vitamin-A [illegible]du[illegible]d fr[illegible]d the p[illegible] oxygenated products of Carotene in blood is not unlikely. Unfortunately, fully hydrogenated Carotene gives the same absorption band at 328 $\mu\mu$ like Vitamin-A so that it is very difficult to distinguish Vitamin-A from fully hydrogenated Carotene by the Spectroscopic method. Now as Carotene acts as a hydrogen acceptor, the fatty acids will be rendered more and more unsaturated, and therefore the Iodine number also increases. Whether the process is a reversible one, is not known. But Carotene has another function to perform viz., helping in the oxidation of fatty acids present in blood. Therefore the greater the Carotene content of the blood, the greater will be the Reichert values of the butter-fats. But there is a limiting value to the Carotene and Vitamin-A contents of blood in spite of heavy ingestion of Carotene-rich foodstuffs. The Reichert and Iodine values of butter-fats have also their limiting values within which they tend to vary.

The results obtained demonstrate that apart from the influencing factors like the period of lactation, temperature differences or administration of oil cakes, the lipochrome pigment Carotene might play some part in the modification of the Reichert and Iodine values of butter-fats and therefore in the metabolism of fats. This is clearly demonstrated by the marked increase in the Reichert and Iodine values of the butter-fats in the experimental cows in spite of the lateness in the period of lactation of the cow. It must be admitted however that the theory suggested in this paper is as yet premature and has to be judged in the light of more experimental evidences. But the results recorded in this paper are highly suggestive and might throw considerable light on the metabolism of fats in the living organizm.

My thanks are due to Principal T. C. Boyd, M.R.C.P., F.R.C.S., F.I.C., Professor H. E. C. Wilson, M.B., Ch. B., D.Sc., Rai Bahadur Dr. K. N. Bagchi, M.B., D.T.M., F.I.C., and Dr. B. Ahmad, Ph. D. for their kind encouragement, helpful suggestions and criticisms.

Department of Chemistry,
Medical College,
Calcutta.
19-11-37.

S. M. Dasgupta.

1 Science & Culture, *3*, 211, 1937.

The Fermentative Production of Citric and Oxalic Acids from "Gur" and Molasses

The problem of the utilization of cane molasses by fermentation has received some attention in different laboratories in India. But the subject does not appear to have been studied on a systematic scale. We have for some time been investigating the products that are obtainable from country "gur" and molasses by the action of different micro-organisms including *Saccharomyces Cerevisiae*, *S. ellipsoideus*, *Aspergillus niger*, *Citromyces*

LETTERS TO THE EDITOR

glaber and a species of *Mucor*. In this communication we are giving some results obtained with *Mucor* under varied conditions.

A "gur" solution containing 3 per cent sugar (calculated in terms of reducing sugar) was used. As sources of nitrogen 1% ammonium sulphate, peptone, casein, gelatin and urea were used in different experiments. The pH was varied between 3 and 7.2 and the temperature of incubation was 28 (room temperature). The following results were obtained:

1. After seven days' incubation with ammonium sulphate as the source of nitrogen the maximum yield of citric acid (33% of the sugar) was obtained at pH 4 and no oxalic acid was formed.
2. After seven days' incubation with peptone the maximum yield of citric acid (29% of the sugar) was obtained at pH 4 and that of oxalic acid (28.1% of the sugar) was obtained at pH 5.6.
3. After 14 days' incubation with ammonium sulphate the maximum yield of citric acid (22.13% of the sugar used) was obtained at pH 4 and no oxalic acid was formed.
4. With peptone, after 14 days' incubation, no citric acid was formed but a maximum yield of oxalic acid (16.75% of the sugar) used was obtained at pH 5.
5. With casein or urea or ammonium chloride after 12 days' incubation citric or oxalic acid was not formed, and, with gelatin, growth of the *Mucor* was not good.

Similar results have been obtained with molasses and it would seem that under favourable conditions yields of citric acid and oxalic acid of the order of 33% and 17% may be obtained and citric acid may also be obtained free from oxalic acid, which is of some significance from the standpoint of its industrial production. Further work is proceeding to find the optimum conditions for the formation of these acids.

Applied Chemistry Laboratory,
University College of Science,
Calcutta.
12-12-37.

G. C. Das Gupta.
K. C. Saha.
B. C. Guha.

The Estimation of Vitamin-C in Food-stuffs

We have described elsewhere[1] certain modifications of the Tillmans-Harris technique, by which a more correct estimate of the vitamin C content of the food-stuffs may be obtained. In this connection three considerations have to be borne in mind: (1) interfering reducing substances have to be eliminated, (2) the dehydroascorbic acid, which is biologically potent, but does not react with the indophenol indicator, has to be reduced, (3) combined ascorbic acid ("ascorbigen"), if present, has to be split up so as to release the ascorbic acid. Work in this laboratory with reference to these points has led to the elaboration of a method, by which more accurate and specific estimates of ascorbic acid are obtained. The method consists in (1) heating the material in a suspension of water with hydrogen sulphide on a boiling water bath for 15 minutes in order to split up ascorbigen and reduce the dehydroascorbic acid present, (2) removing the hydrogen sulphide by a current of nitrogen or carbon dioxide, (3) extracting with trichloroacetic acid, and (4) titrating one portion with the indophenol indicator and another portion after incubation with ascorbic acid oxidase (prepared from cucumber or white gourd) (see also Tauber, Kleiner and Mishkind[2]). The difference in titration values gives the content of ascorbic acid. Details will be published later.

Applied Chemistry Laboratory,
University College of Science,
Calcutta.
12.12.37.

P. N. Sen Gupta.
B. C. Guha.

1. Sen Gupta and Guha, *J. Ind. Chem. Soc.*, *14*, 95, 1937.

2. Tauber, Kleiner, and Mishkind, *J. Biol. Chem.*, *110*, 211, 1935.

On Cellulose—Lignin Combination

On account of the difficulty in removing lignin from cellulose and the high insolubility of wood substances in Schweitzer's reagent, Erdmann[1] suggested a chemical combination between cellulose and lignin. According to Lange[2] the linkage is of ester type: while Hoppe-Seyler[3] regarded it as an ether. In any case, the only reactive groups in cellulose are in the (OH); these are assumed to take part in the combination. As regards the occupation of (OH) groups in cellulose or lignin, through combination, the experimental evidence so far put forth is not convincing.[1]

Genuine lignin has been found to be insoluble in all media and so its easy separation by means of solvents is out of the question. Secondly, Freudenberg and co-workers[5] have succeeded in isolating lignin from pine wood by alternate treatment of the wood with 1% boiling sulphuric acid and copper oxide ammonia. The difficulty in dissolving cellulose of the wood in the latter might as well be due to the protective action of lignin. Cross and Bevan,[6] Cross and Doree[7] as well as Konig and Rump[8] hold that cellulose and lignin exist side by side without any chemical combination. The adsorption hypothesis Wislicenus[9] also supports the same view. It has been shown by Clark[10] that lignin present in wood is essentially amorphous in giving X-ray defraction patterns with only one or two very diffused rings and it does not in any way interfere with the crystalline pattern of cellulose. So they are not in chemical combination. Recently Freudenberg[11] also has supported the incrustation hypothesis. Lignin has been separated with 2% aqueous alcoholic NaOH in the cold by Phillips[12] and Beckmann and others[13] from oat hulls, corn cobs and rye straw. An ether linkage would hardly be ruptured under these conditions.

In the course of tensile strength measurements of of jute fibre under various conditions[14] it has been observed by the author that jute fibre completely delignified by ClO_2 retained its physical structure as seen side by side with the raw fibre, under the miscroscope. Also the tensile strength of delignified jute in the air-dried condition was very nearly the same. This would indicate that lignin is not chemically combined with cellulose in jute. Otherwise this important physical property namely tensile strength, would have changed considerably. The removal of lignin would have resulted in a more or less complete breaking down of the organized structure and consequently, a marked change in the appearance should have taken place.

It was observed by the author that when cellulose (cotton, jute and bamboo) were treated with 72% H_2SO_4 or 42% HCl at 0° to 4°, for an hour or two, and then poured into crushed ice, cello-dextrine in the form of a fine powder was obtained in all cases. The lower mol. wt. as determined by viscosity and surface tension methods[15] showed that they were degradation products. Raw jute gave a rosy paste on similar treatment, from which cello-dextrine could be obtained by removing lignin by ClO_2

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This was identical with that prepared from delignified jute. Both had practically the same mol. wt. The rosy paste as a well as the cello-dextrine from cellulose, blackened at 100°. Thus, cellulose could be degraded in the same way even when lignin was present. This points to the view that all the cellulose in jute is free and not combined with lignin.

Thirtdly, dry Cl acted on raw jute (also dry) to give a chloro-lignin with precisely the same property and constants as that from separated lignin, in carbon tetra chloride suspension[16]. The oxidizing action of moist Cl is not necessary to disrupt the so-called union between cellulose and lignin. Moreover, no definite ratio between the weights of lignin and cellulose in ligno-celluloses has yet been established to justify their combination. In view of these facts, the author considers that lignin and cellulose are not chemically combined in jute. The homogenous distribution of the lignin along the fibre as observed by the author[17] does not prove anything definitely as regards its chemical union with cellulose; in the case of physical adsorption as well such homogenous distribution is not precluded.

Department of Chemistry, Vidyasagar College, Calcutta. 10.12.37.

P. B. Sarker.

1. *Ann*, *138*, 1, 1866 , *ibid*, supplement V. 223, 1867.
2. *Z. physiol. Chem.* *14*, 15, 283, 1889
3. *Z. physiol. Chem.* *13*, 84, 1888.
4. Cf. Sen and co-workers, *J. Indian Chem Soc.* *6*, 676, 1929 ; Fuchs and Horn, *Ber.* *62*, 2647, 1929.
5. *Ber.* *62*, 1814, 1929.
6. *Researches in Cellulose*, 4, 170, 1922.
7. *Ibid.* p 152
8. *Chemie u Structur der Pflanzen-zellmembran.* p 85, 1914.
9. *Kollo d Z.* 27, 209, 1920; *Cellulosechemie* **5**, 45, 1925.
10. *Ind. Eng. Chem* *22*, 483, 1930.
11. *J. Chem. Education.* *9*, 1171, 1932.
12. *J. A. Chem. Soc.* *50*, 1986, 1928 ; *ibid.* *52*, 793, 1930.
13. *Loc. cit.*
14. Sarkar, *J. Indian Chem. Soc.* 12, 23, 1135.
15. Chowdhury and Bardhan, *J Indian Chem. Soc.* *13*, 1936, 240.
16. Sarkar, *J. Indian Chem. Soc.* *11*, 777, 1934.
17. *J. Indian Chem Soc.* 8 397, 1931.

Structure and Development of Jute Fibre and the Factors determining Yield and Quality.

Investigations on Jute fibre have been chiefly made on extracted fibre, and there are widely divergent views as to its physical structure and chemical composition. Jute fibres are known to differ in chemical composition, tensile strength, lustre, colour, degree of fineness and length when produced under both similar and dissimilar conditions.

Our original idea was therefore to determine the causes of such variations, a subject of considerable economic importance, by a study of the physical structure, chemical composition, the methods of fibre formation and subsequent changes in the fibre during the plant's life.

During the course of our investigation several significant facts have come to light, a short report of which will be made in this paper.

The term fibre in Jute refers to a strand which in reality is composed of many cells and depending on the type, range in number from 4-40. Each cell is called an ultimate fibre or cell which measure 1.5 3.5 mm. in length and 10 15μ in width in different varieties. Each ultimate fibre is spindle-shaped with several transverse walls in it.

Cells that are to be formed into fibres originate from a layer of undifferentiated parenchymatous elements from

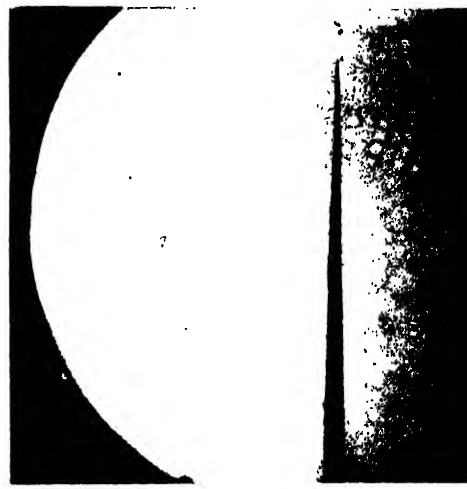

Fig. 1

the meristematic region of the stem tip. They lie just below the endodermis, i.e., in the pericycle region (Fig. 1). With the growth of the plant the thin-walled parenchymatous cells are converted to prosenchymatous form. Further layers of fibres subsequently originate by the

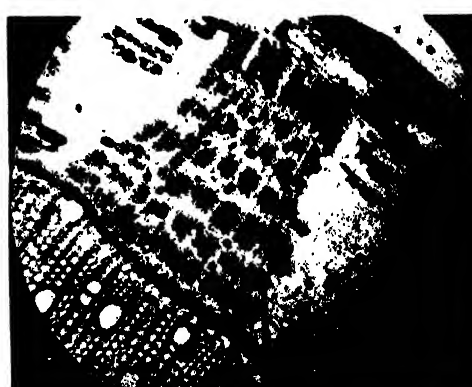

Fig. 2a

activity of cambium and are pushed towards the periphery by the secondary growth of the wood. In each layer there are several groups of fibres, called composite fibres, which are separated by intervening parenchymatous cells.

LETTERS TO THE EDITOR

Comparative study of different varieties at the same stage of development and at the same region shows that the number of layers, the number of composite fibres in a layer as well as the number of ultimate fibres in each composite fibre vary widely (Fig. 2a, b). These characters

Fig. 2b

of fibres are of great practical importance as the yield of fibre and the degree of fineness of fibres are dependent on them. The more the number of ultimate cells in a composite fibre the coarser it is, the less the number the finer it is (Fig. 3a, b).

Measurements taken from the cross sections of the base and tip of a stem reveal differences in the size of the fibre as well as in the thickness of the cell wall of the fibre. Each cell of the fibre when first formed is surrounded by a thin

Fig. 3a

wall which is called primary wall or middle lamella and is chemically composed of cellulose. During the period of active growth, each ultimate cell becomes elongated with tapering ends and increases in diameter with a corresponding increase in the length and diameter of the stem. During this stage there is also an increase in thickness of the cell wall by the deposition of a cellulose layer which is known as the secondary wall. Cross sections taken from the base of a stem of mature plant after the period of rapid elongation show a further enlargement in thickness of the cell wall but without any difference in the size of the cell. This thickening of the cell wall is known as tertiary thickening and is due to the addition of separate layers of cellulose formed periodically by the process of apposition. Each tertiary layer formed is pushed to the secondary wall by turgor

Fig. 3b

pressure. After this, further layers of cellulose are formed and are added to the cell wall. These layers are independent of each other without any cementing material between them and vary in number from 3-7 in different cells. The fibre is formed in this way and shows a stratified appearance under the microscope (Fig. 4).

Microchemical studies of fibre from different stages of development show that the middle lamella which was originally of cellulose matter is converted first into pectin and finally to lignin. Sections cut from the top region of a

mature plant showed that secondary wall and some layers are also lignified, but sections taken from the basal part of the same plant showed that lignification was most widespread here, almost all the layers being lignified. Lignification therefore starts from the middle lamella and continues into the secondary wall and ultimately into the tertiary wall with the increasing age of the plant.

LETTERS TO THE EDITOR.

Fibres extracted from plants harvested at different stages of their growth show differences in colour, strength and harshness. Fibres from plants harvested at the time of ripening of seeds were very harsh, brittle and reddish; whereas the fibres from plants harvested earlier at the time of flowering stage were strong, pliable and white. Microchemical studies of the extracted fibre from the former showed a greater amount of lignification in the fibre cells i.e., the harsh reddish and brittle fibres were due to more lignification. Extracted fibre from plants cut at earlier stages showed a smaller amount of lignification and the fibres were white, pliable and non-brittle. Lignification of jute fibre therefore is of vital importance in determining the quality of fibre. The critical stage in determining the proper time of harvesting the crop is the degree of lignification that has occurred, a factor which is of great economic importance.

Retting as is used here means decomposition of soft tissues by bacterial action when the plants are kept under water and consequent separation of the fibres from the stem. The retting process has been studied in detail by carefully following the stages at different intervals. The portions that are first attacked by bacteria are the cambium and the soft bast which separate the pericycle from he wood. This decomposition gradually proceeds towards the intervening parenchymatous tissues in the fibre region of the pericycle, and the composite fibres are separated (Fig.5).

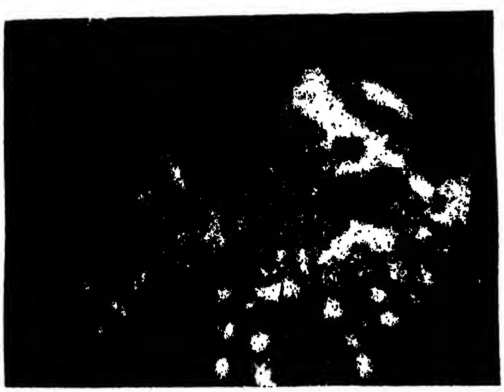

Fig. 5

The epidermal and sub-epidermal layers are not attacked by bacteria and therefore remain intact. The primary, secondary and tertiary walls of fibres are not attacked by bacteria due to their impervious nature and absence of intercellular spaces in them. The ultimate fibres are therefore not separated and the composite fibres are obtained in strands many feet in length.

It was further observed that when the plants were kept too long a period in the fermentation tank the fibres became weak and sometimes individual fibres were separated while kept too short a period the fibres did not easily separate from the adjoining parenchymatous tissues. The most critical period in the retting process is therefore the extent to which the softer tissues have been removed, the incomplete destruction of which lowers the quality of jute fibres to a great degree.

Thus our study shows for the first time that the yield, length and degree of fineness of fibre are dependent on the genetic constitution of the varieties modified by environmental conditions. The colour and strength of the fibre are due to the extent of the presence of lignin and subsequent treatment of the fibre during the process of retting, washing and drying. Retting is merely the destruction of soft parenchymatous tissues by bacteria and this again is dependent on the age of the plant, temperature of the retting water, stagnancy and presence of matter in the water.

Bose Research Institute, Calcutta.
15.12.37.

H. K. Nandi.
J. N. Basu.

A Note on the Experiment to Investigate into the Effect of Dusting Paddy Plants with Paris Green Powder on the Yield of Grain and Straw

The campaign of dusting paddy fields with Paris green powder as a larvicide against the mosquitoes has been undertaken by the Railway administration in India in conconnection with antimalarial project. It is reported that the dusting is successful in imparting a lethal effect on the mosquito larvae. But unfortunately the campaign has received a setback due to the objections raised by the cultivators on the ground that the treatment with Paris green affects the yield of paddy adversely.

This department was requested by the Malariologist, B. N. Ry., to perform suitable experiment for finding out the effect of dusting paddy plants with Paris green powder. Accordingly, last year an elaborate field experiment on transplanted aman paddy was designed. 30 unit plots of 9'-9" square each were arranged in 10 adjacent blocks, representing 10 replicates of the series of the treatments under test and each unit plot was surrounded by 1½' ally to facilitate the dusting operation. Within each such block there were altogether 3 unit plots, representing the three different treatments,- morning dusting (between 9 a.m. and 11 a.m.) (2) evening dusting (between 3 p.m. and 5 p.m.), (3) Control (no dusting) arranged at random.

The paddy selected for the experiment was Dacca No. 1 (Indrasail) a medium pureline strain of the transplanted aman group. Single plants of the same were transplanted 9" apart within each experimental plot. There were altogether 196 plants in each of the unit plots under experiment.

Paris green of the strength of 2% was prepared by diluting the commercial stuff obtained from Messrs Wilkinson Heywood & Clarks' firm with requisite quantity of fine soft stone powder. The quantity of mixture, dusted on each occasion on the experimental plots, was at the rate of 50 lbs to the acre.*

Altogether ten dustings were done, commencing from 7.10.36. on every fifth day and ending on the 22nd November, 1936. The dusting which was due on the 16.11.36. was slighted by one day due to rains. The dusting was started about a fortnight previous to the flowering date, (23rd Oct.) i.e., at the ""thormukh stage" when the sheath enclosing the flowerhead was gradually swelling up prior to the emergence of the inflorescence. The closing day of the dusting operations corresponded approximately with the end of of the "milk stage", i.e., when the grain has become hard prior to maturity.

For the purpose of dusting a new medium sized handpower blowing machine was obtained on loan from the Malariologist, B. N. Ry., and it gave the desired "misty evennes."

At harvest 100 plants were taken at random from the centre of each plot, after rejecting the outer-most row of plants to eliminate the border effect, for weighment of grain and straw. The grains from each plot were weighed twice i.e., once before winnowing and again after removing

the undeveloped grains (husks). From the difference in yield, the loss of weight due to husks was worked out.

The analysis of variance and the results are given below:—

Table I.

Analysis of variance (on gross grain weights in tolas).

Variance due to.	Degree of freedom.	Sums of square.	Mean square.	S. D.
Treatment.	2	9056.56	4528.28 **	
Block.	9	803.04	89.23	
Error.	18	1303.17	72.39	8.50

** Significant at 1% level.

S. E. = 2.69.

Table II.

Analysis of results.

	Morning dusting.	Evening dusting.	Control.	General mean.	Error.
Wt. of 100 plants in tolas.	110.15	106.90	145.27	120.77	2.69
Wt. percent.	91.20	88.51	120.28	100.00	2.23

Table III.

Analysis of variance (on net grain weights on tolas).

Variance due to	Degree of freedom.	Sums of square.	Mean square.	S. D.
Treatment.	2	11543.12	5771.56 **	
Block.	9	857.82	95.31	
Error.	18	1266.05	70.33	8.38

** Significant at 1% level

S. E. = 2.65.

Table IV.

Analysis of results.

	Morning dusting.	Evening dusting.	Control.	General mean.	Error.
Wt. of 100 plants in tolas.	87.35	88.45	129.50	101.77	2.65
Wt. percent.	85.83	86.91	127.24	100.00	2.60

Table V.

Analysis of variance (on dry weight of straw in tolas).

Variance due to	Degree of freedom.	Sums of square.	Mean square.	S. D.
Treatment.	2	391.03	195.51	
Block.	9	2528.60	280.95	
Error.	18	7170.93	398.38	19.95
Total	29	10090.56		

S. E. = 6.31.

Table VI.

Analysis of results.

	Morning dusting.	Evening dusting.	Control.	General mean.	Error.
Wt. of 100 plants (straw) in tolas.	139.00	141.05	147.47	142.51	6.31
Wt. percent.	97.53	98.97	103.48	100.00	4.42

The figures in tables II and IV afford sufficient proof of the deleterious effect on the yield of paddy plants dusted with a 2% Paris green powder.

It may be seen that the difference in yield in favour of control as against either of the treatments "morning dusting" or "evening dusting" is, in each case, absolutely significant under the conditions of the experiments.

The following features as brought out by the experiment are worth noticing:—

(1) That the fall in the yield of grain due to dusting with Paris green is wellnigh 20% on the whole. This is tentatively due to interference of the powder on the proper growth and development of the grains.

(2) That the deleterious effect is positively patent and independent of the time of dusting.

(3) That there is practically no effect of dusting with a 2% Paris green on straw, healthy as reported by Nicholls (Ceylon Jl. Sc. Sect. D. 11, 1, pp. 21, 30, 27) or harmful, as is clearly evident from the absence of any absolute difference in yield either in favour or against the treatment. Moreover no trace of apparent deleterious effect of the powder on the green leaves was noticed.

It is intended to do the experiment again during next year with one or two more larvicides in addition. Attempt will also be made to determine the underlying causes of the deleterious effect of the larvicides on the yield of paddy.

In conclusion we offer our thanks to Mr. Senior White, the Malariologist, B. N. Ry., for lending us the "Blowing machine" without which it would not have been possible to conduct the experiment.

Laboratory of the Economic Botanist, Dacca.
23.11.37.

S. H. Hedayetullah
Kali Prasanna Roy

[1] The diluent, the strength and the quantity of the mixture for each was in accordance with the practice of the Malariologist, B. N. Ry. in his campaign.

A new species of Phoebe from Assam

Phoebe assamica *kalyan kumar* (spp Nov.). Family-Lauraceae Vern. Mekahi (Assamese). *Phoebe attenuata Nees affinis, sed foliis Longioris, petiolus longoris. Fructus majoris different.*

A large evergreen tree, bark whitish grey, branchlets marked with scars of fallen leaves. Young shoots, petioles & inflorescence covered with rusty tomentum. Leaves simple, crowded towards the ends of branchlets. 10-30 cm. · 5-13.5 cm. Broad elliptical lanceolate, cuneate, entire pubescent along midrib otherwise glabrous above. Undersurface glaucus, rusty pubescent along midrib and lateral nerves Midrib and lateral nerves prominent beneath. Lateral nerves 14-15 acruate anastomosing towards the margin. Petiole channelled above, about 2-2.5 cm. Flowers in axillary panicles. Rachis 13-20 cm. in length, tomentose.

Flowers hermaphrodite, small about 4 mm long and 4 mm across, pedicel 6-8 mm. long. Rusty tomentose slightly thickened upwards. Perianth segments 6 imbricate, ovate, elliptic, concave 4×2 mm. thickly tomentose outside, marked with 3-5 longitudinal lines.

Stamen perfect stamens 9, staminodes more or less connate at the base, filaments of fertile stamens 2 mm long and that of stamonidoes 1 mm. flat villous, anther cells 4 opening by valves. Ovary compressed 1.5 mm long, one celled. Style simple 3 mm long. Fruit a berry 3 cm × 2 cm. supported by accrescent perianth segments.

Flower—May -June, Fruit Sept. October.

I reveived this specimen from my relation Mr. Purkayastha, Dy Conservator of Forests, who was working in Sadiya forests at that time. It proved to be a new species as it could not be matched either at Kew or at the Royal Botanic Garden, Sibpur. The description was written by me some time ago, but it could not be published till I received Mr. Purkayastha's notes.

This is a very good timber tree of the N. E. Frontier tract. The spp comes near Phoebe attenuata but differs from it in having much longer and broader leaves with long petioles. The fruit is also much bigger in this case.

Asutosh College Calcutta. 10-11-37.

Kalyan Kumar Purkayastha

On a Boulder Bed in the Krol Hills near Solon.

During a recent visit to the Simla Hills with a party of post-graduate students of geology the author came across a peculiar boulder bed in the vicinity of the Krol Hill about two miles north of Solon. The bed shows features which are indicative of its glacial origin. The author belives that there is in this bed an evidence of Pleistocene Glaciation in the Solon Simla area not so far recorded by previous workers in this field.

The Simla Hills form a classical region of the Himalayan geology. Numerous workers, trying to unravel the structure of the mighty range, have turned to this area in search of clues that may help in the elucidation of the structure. The latest of these efforts have gone to show that the structure, far from being simple, is an extremely complicated 'nappe' involving the development of several overthrusts together with horizontal movement of strata over considerable distances.

The newly discovered boulder bed is of a sporadic occurrence apparently taking no part in the intense earth movements that resulted in the rise of these high mountains. It resembles in certain respects the boulder beds of the Blaini Series which also have been involved in the folding, but the field relations, as also some other characters, mark it as a distinct bed formed much later than the last orogenic upheaval.

Solon is the type area where the Blaini conglomerate bed was first discovered and studied by Medlicott[1]. The same has been studied by several workers and is now considered as the index horizon of the Himalayan Geology.

There are a few exposures of the Blaini Boulder bed in the neighbourhood of Solon already mapped by Pilgrim, West and Auden. Two of these crop out in the bed of the Blaini stream a mile west of the Solon railway station, while the third is about a mile and a half south west of Solon on the road to Barog. In the Blaini stream exposures it occurs as thin strips running N.W. S.E. nearly parallel to the stream for over one mile and is in one case underlain by the Simla slates on the south and succeeded by the Infra-Krols on the north. The southwestern exposure on the Barog side, however, is associated only with the Infra-Krols on either side. The Blaini Conglomerate band is extremely hard and is composed of boulders of various sizes in a fine but compact grey matrix. The boulders are those of ancient schists, quartzites and slates, apparently belonging to the pre-Cambrian metamorphics, on which however the author did not observe any facetting or striations.

The Blaini bed is intimately involved in the intense folding associated with the Himalayan upheaval. The bed, moreover, is not found associated with rocks younger than the Infra-Krols in the Solon area.

The new boulder bed, which forms the subject matter of this communication, differs strikingly from the Blaini Boulder bed which occurs within two miles of its exposures. Several outcrops of this new boulder bed were located on the slopes of the Krol Hill and in the adjoining valleys. The best exposure is the one between Chambaghat and Basal about a mile and a half to the N.W. of Solon. Here it occurs as a regular bed with a roughly southerly dip conforming to the slope of the hill and covering unconformably the beds of the Krol and Infra-Krol series. A small streamlet exposes the junction of the boulder bed with the underlying rocks and a strong discordance is evident. The boulder bed continues for a fairly good distance down the stream and is composed of unassorted fragments, often of large size, of quartzites, gneisses, shales, slates, and limestones, all held together in a fine matrix of soft mottled clays. The fragments of shales, slates and limestones, as also the clays, are derived undoubtedly from the underlying Krols and Infra-Krols of which they are the predominant components.

A few detached outcrops have been traced within the Solon Cantonment area, one of these being directly in contact with the Subathus and the Infra-Krols. In this exposure the Subathus form a small asymmetrical anticline with the fold axis running nearly N.W.-S.E. These rest with great unconformity over the brown and purple slates of the Infra-Krols, dipping somewhat steeply to the north-east. The strike of the Infra-Krols is nearly the same as that of the Subathus, but the marked difference in the amount of their dip, as also in the lithology, easily serves to mark the intervening unconformity.

The boulder bed is seen in this area covering partly the Subathus and partly the Infra-Krols; and this relation is very clearly exhibited in a section exposed by a small streamlet within a furlong west of the play ground in the Cantonment area.

It is thus apparent that lithologically this bed is quite distinct from the typical hard grey Blaini Conglomerate occurring in this area. The field relations moreover clearly point to its being much younger than the Infra-Krols the Krols and even the Subathus all of which it covers with great unconformity and which in turn is nowhere overlain by any rock formation. The fact that this bed conforms to the slopes of the Krol hill and lies more or less undisturbed shows that it has not been subjected, since its formations, to any of the major mountain building disturbances in this part of the Himalayas and, that the boulder bed is therefore much younger than the last phase of this Himalayan upheaval—possibly Post-Pliocene in age. Numerous exposures of this boulder bed were observed on the eastern slopes of the Krol hill both along the railway and the motor road between Solon and Kandaghat. No such rocks were, however observed beyond Kandaghat even up to Simla along either of the routes; and though we cannot rely much on this negative evidence, this at least suggests that the Krol Hill which is the highest (7393') within several miles of this

part of the region, must at one time have been one of the very few seats of glaciers in these parts.

Boulder beds of Post-Tertiary age are known from some of the neighbouring areas in the Himalayas. Theobald, in 1874, described certain glaciers of the Kangra District[2] which according to Oldham were of Post-Pliocene age. The outcrops of these Kangra glacial beds extend as far east as Bilaspur only 32 m. N. W of Simla. Similar occurrences of glacial boulder beds near Dalhousie were described by McMahon[3] in 1882. It is thus clear that this part of the Middle Himalayas was the scene of pleistocene glaciation along with several other parts, the glaciers, later, having completely disappeared from this part of the Himalayas.

Department of Geology,
Benares Hindu University. K. P. Rode.
15-12-37.

1. *Mem. G.S.I. 8*, Pt. 2, p 17, 30. 1864.
2. *Rec. G.S.I.* 7, Pt. 3, 86-97.
3. *Rec. G.S.I.* 15, pp, 49-50.

Discovery of Dublabera Vanadium.

With reference to the controversy regarding the discovery of what has been called "coulsonite," the following facts may throw some light on the subject.

In 1929, being interested in manganese and being informed of its presence in Sindurpur Hills in Dhalbhum, I went there for prospecting with my informant Mr. Purna Chandra Chatterjee. I came across certain floats and inspected them with my eye-lens. These showed on breaking fine crystalline structure with a pitch-like matter in the intra-crystal spaces. We had also some samples procured near Dhangam—Dublabera road. The accidental find of a lodestone in this area led me to suspect them to be magnetite.

Some Sindurpur samples were also procured, which were of needle-shaped crystalline form and steely in appearance. These samples were analysed by me at the Dacca University laboratory and found to be a very pure nickeliferrous ore containing about 70% Fe and about 1% Ni.

A spectrum analysis of the Dhangam samples carried out by Prof. S. N. Bose of Dacca University showed the presence of vanadium. Subsequent quantitative analysis carried out by me in Dr. N. K. Sen's laboratory in the Dacca University revealed that the ore contained as much as 4% vanadium. Analytical figures were 8.7% V_2O_5, 28% TiO_2 and 56% Fe_2O_3. This was considered both by Prof. S. N. Bose and Dr. N. K. Sen to be a unique ore with regard to the vanadium content. Further work on other samples obtained from the field to pick out the rich vanadium lode was kindly undertaken by Dr. P. B. Sarkar of the University College of Science, Calcutta, to whom I was introduced by Prof. S. N. Bose. Dr. Sarkar was greatly interested and analysed about 30 samples in 1931.

The Oriental Export and Import Co of 1/C, Swallow Lane, Calcutta (now defunct) acted as our agent. In 1931, samples were also sent to the Geological Survey of India. But apparently no notice was taken by them. Samples were also sent to the Imperial Institute of Technology, London. Negotiations were started to interest Tata Iron and Steel Co. Ltd., through a Parsee firm during 1932-33 as a result of which Mr. Balaram Sen of Tatas twice visited the field in 1933 and I guided him through the area.

The interest of the Geological Survey of India was apparently finally aroused by information which was sent to them by the Imperial Institute of London, what had analysed our samples. Dr. J. A. Dunn of the Survey went by himself and, so far as our information goes, reported that he had found no vanadium ore in the area. His failure prompted the Survey Office to take our help and Dr. A. K. Dey was sent accordingly, who went there in 1933 and I myself showed him the field over.

This, I think, throws some light on the course of the discovery of Dublabera vanadium.

29, Balaram Bose Ghat Road,
Bhowanipore, Subodh Chandra Ghose.
Calcutta.
10. 12 37.

SCIENCE AND CULTURE

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Need for a Power Research and Investigation Board in India

In his presidential address before the 3rd annual meeting of the National Institute of Sciences of India, Professor M. N. Saha has clearly pointed out that if India is ever to solve her problems of poverty, ignorance and disease, it can only be done by largescale industrialization of the country. India is essentially an agricultural land, 66% of whose population are peasants or, to use Professor Gordon Child's phraseology, mere food-gatherers; 23% of the remaining 34% follow occupations dependent on a rural economy, and only 11% are city-dwellers. It is only these 11% of the total population of India who are engaged in industries or other urban professions. In no other country of the world, excepting such back ward ones as China, is there such a large proportion of rural population. The condition of the villagers is anything but satisfactory. Half starved, without even two square meals a day, living in huts mostly without doors and windows, sleeping on mats and with rags on, and often without them, pressed with heavy burdens without any relief, encumbered with ever-increasing debts and afflicted by diseases, the Indian peasant drags out his miserable existence from day to day. True, there is a keen desire everywhere and an attempt in some quarters to improve his sad lot and to raise the general standard of living. In this connexion the point of view is often urged that the problems of India's poverty, illiteracy, and diseases can be solved, if there is an exodus of townsmen to the villages. It will, they say, eliminate middle-class unemployment. But this will only lead to an increase of the pressure on the over congested rural areas and will multiply misery. If we, on the other hand, insist on greater efficiency in agricultural methods, and if up-to-date scientific methods replace the age-old crude ones followed by the farmer in our country today, they will no doubt yield more abundant and cheaper food. This means that the same production in agriculture can be effected through the application of modern scientific methods in lieu of old ones, by half the present number of tillers of the land. A larger amount, more than sufficient for the whole of India, can be produced by 30% of her population. That means the rest will sit idle and unemployment will increase. What, then, is the solution? Professor Saha analyses the situation and recommends large-scale industrialization as the only way out of this difficulty. He says:

"If we analyse the widespread public sentiment for better living, what do we find? Everybody of course wants his food supply to be insured, but this is the least part of his demands. He wants to be better clothed and better

housed; wants to get a better education for himself and his family, more rest from work, freedom from drudgery and greater enjoyment of life. Analysing the sentiment we find that if these needs are to be satisfied, the quantity of industrial products has to be increased ten to twenty times its present level; all these works have to be organized, and a large proportion of the village population is to be diverted from the task of food-gathering to industrial work. In fact, the only way to improve the villages is by drafting more villagers to the cities, and by creating a large number of cities based on industries."

It can be asked by some: Is India fit for industrialization? We agree that all countries cannot attain industrialization due to their intrinsic poverty of natural resources. "The source of potential wealth today is not merely good agricultural land of all varieties, capable of yielding all kinds of food and other economic products, but also mines, capable of yielding minerals useful to man, and sources of power (coal, oil, peat and other fuel, water power)." India is one of the three countries which enjoy potential plenty, the other two being U.S.A. and Russia. She possesses all sorts of natural resources in abundance, yet she continues to be poor, only because her resources have not been developed and industrial work has not been properly planned and organized. Dr Vera Anstey says in her *Economic Development of India*: "Here is a country of ancient civilization, with rich and varied resources, that has been in intimate contact with the most materially advanced countries of the West, but which is still essentially mediaeval in outlook and organization, and which is a byeword throughout the world for the poverty of her people." What is the root cause?

Not only has the natural wealth of India not been fully exploited and her power resources developed, but the power that is already available is extremely dear. The price of petrol in this country varies from Re. 1/- to Re. 1/10/- per gallon, while that in England or Japan is only -/6/- annas; and on account of the great cost of petrol oil engines are very expensive to work in this country. It is on this basis estimated that in the European countries the cost of power forms about 3% of the total manufacturing charges. The cost of power in India, on the other hand, is 12% of the total manufacturing charges. This shows how much India is handicapped in the matter of industrialization. In fact the first stage towards successful industrialization is cheap power. In order that this matter be properly investigated it is necessary that the Government should establish a Power Research and Investigation Board as is done in many other countries of the world, *e.g.*, England and Russia. Let us take the instance of Russia which was in the pre-Revolution days a wholly agricultural land, consisting of 70% of rural population. After the Revolution, under the able guidance of Lenin, they increased their power resources, started schemes for planned electrification for the whole country and eventually, when equipped with highly developed resources, industrialized it on a large scale. She has passed from a wholly agricultural country to an essentially industrial one with 70% of her population now engaged in industries. Soviet Russia, to give full effect to the schemes and make them a success, adopted, under the guidance of Prof. Krzhizhanovski, the plans of (1) Immediate establishment of a Power Research Institute for undertaking the survey of the existing power resources, coal, peat, oil, shale and, above all, water power in the U. S. S. R., (2) Establishment of an extensive scheme of hydrological Survey—so far the U. S. S. R. possesses 5,200 hydrological stations of all classes, for surveying the discharge of rivers at different points, their variation throughout the year, etc., (3) Establishment of a large number of River Physics Laboratories at Tashkent, Moscow, and Leningrad and other centres where researches with laboratory models of projected weirs, dams, embankments, canals are carried out before any work is actually undertaken, (4) Establishment of a comprehensive scheme for training an army of technicians in Russia.

The phenomenal growth of Russian industry during the last few years proves the correctness of the adoption of these plans. She "now installs every year power stations of millions of kilowatts capacity instead of thousands. The energy produced is utilized by the properly planned industries, and in transport, and only

small percentage is also utilized in agriculture. Thus within the last sixteen years, the nation has passed from a community of half-starved peasants to well-fed and well-clad industrial workers."

Electrical power in almost all parts of India can be obtained out of the energy of the running water. But as all hydroelectric schemes are expensive, we should urge that before such a scheme is launched, thorough preliminary studies be made. These would include, as pointed out by Prof. Saha in his address, a summary of the water power resources showing the variation of discharge of rivers, possibility of erecting storage reservoirs, finding out the best site, and further economic survey with a view to utilization of all the power developed. Even when a site has been chosen, extensive laboratory experiments should be carried out with the aid of models on the proposed dams, weirs, reservoirs, etc., before any work is actually undertaken. If one goes critically into the history of the unsuccessful work of the Mundi Scheme in the Punjab and the Western Ganges Hydroelectric Scheme, both of which hold the world's record for dearness, one will find that the root cause of failure was that schemes were launched by enthusiasts (in many cases by amateurs in hydroelectric engineering) without sufficient survey and preliminary experiments. In the Mundi Scheme, nearly 6 crores of rupees were wasted before it was discovered that the river from which power was to be tapped almost ran dry during the hot season. If a small part of this money was spent on adequate surveys, and preliminary laboratory researches, probably the Governments would have received a handsome return on their investment, most part of which has now to be written off as unproductive.

Thus we see that for the largescale industrialization of India the development of power resources is absolutely essential. We must, at the same time, urge that if we want industrialization to proceed on sound lines, we should admit the necessity of establishing a Power Research and Investigation Board, which would make scientific studies of the various problems that may arise from time to time and advise the authorities on the course of their future procedure. We conclude with Prof. M. N. Saha:

"If we desire to fight successfully the scourge of poverty and want from which 90% of our countrymen are suffering, if we wish to remodel our society and renew the springs of our civilization and culture, and lay the foundations of a strong and progressive national life, we must make the fullest use of the power which a knowledge of Nature has given us. We must rebuild our economic system by utilizing the resources of our land, harnessing the energy of our rivers, prospecting for the riches hidden under the bowels of the earth, reclaiming deserts and swamps, conquering the barrier of distance and above all, we must mould anew the nature of man in both its individual and social aspects, so that a richer, more harmonious and happier race may people this great and ancient land of ours. Towards the realization of this ideal, we must adapt ourselves to the new philosophy of life and train the coming generations for the service of the community in scientific studies and research."

The Bearing of the Domestication of Animals on Human Civilization, with Particular Reference to India

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THE history of human civilization is so intimately bound up with the domestication of animals that for a proper understanding of the former it is essential to have as detailed a knowledge as possible of the sequence of events that led man to take to the domestication of wild animals with a view to making them his companions and helpmates. Unfortunately the problems involved in this study are so complex and their elucidation, owing to the paucity of information and material, so difficult that it is not easy to arrive at a clear understanding. In the following account an attempt is made to present some of the more important lines of thought, indicating the progress that has been made in the study of this very difficult subject; in connection with the latter special attention is devoted to the importance of India as a centre of domestication of animals.

Before dealing with the main theme it is essential to preface it with a short outline of our ideas in reference to Organic Evolution.

Leaving aside the semi-popular views of the Eternity of Present Conditions and the Catastrophisms, the two main theories in reference to the occurrence of the numerous kinds of plants and animals on the earth are: 1. The Theory of Special Creation, and 2. The Theory of Organic Evolution. The theory of Special Creation is a literal interpretation of the Mosaic account of creation as set forth in the first chapter of Genesis in the Bible—it is a simple story derived from the Hebrew tradition, beautifully told and admirably suited to the times and the simple, believing people for whom it was written. One of its greatest exponents since the advent of the Christian era was a Spanish Jesuit priest, Father Suarez, who in the latter half of the sixteenth and the early years of the seventeenth centuries stated that "the world was made in six natural days" by an all-powerful Creator. His influence was so profound that this continued to be the orthodox belief in Europe until the middle of the nineteenth century. In England the famous poet, Milton, influenced Protestant thought by his beautifully written account in *Paradise Lost* of how, on the sixth day, in accordance with the Divine Command

"The earth obeyed, and straight,
Opening her fertile womb, teemed at birth,
Innumerous living creatures, perfect form,
Limbed and full grown."

It was apparently this idea of the creation of different kinds or *species* of plants and animals that led the famous Swedish naturalist, Linnaeus, about the middle of the eighteenth century to expound his famous dictum that "the number of species is as many as different forms were created at the beginning," and that "the individual creatures are produced from eggs, and each egg produces a progeny in all respects like the parents." The views of the French School, and more particularly of its leading exponent, Cuvier, in reference to the immutability of the species are well summed up in the sentence, "species are as distinct as the different makes of boots sent out from a factory." The publication of Charles Darwin's epoch-making work, *The Origin of Species*, in 1859, however, revolutionized our ideas in reference to creation and evolution of the organic world. Darwin, as a result of very careful studies extending over many years, maintained that species are not immutably

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fixed but pass into one another, the modifications of the species being effected chiefly through " the natural selection of numerous, successive, slight favourable variations; aided in an important manner by the inherited effects of the use and disuse of parts; and in an unimportant manner – that is, in relation to adaptive structures, whether past or present—by the direct action of external conditions, and by the variations which seem to us in our ignorance to arise spontaneously." Since this date his theory of Organic Evolution has been accepted, more or less generally, as the only logical way of understanding and interpreting Creation. The theory is based on the well established fact that even no two individuals of the same species of plants or animals are alike—there being always slight differences or *variations* in size, shape, colour, etc. Owing to the very rapid rate at which all living forms tend to increase there is a continual *Struggle for Existence* in the competition for food, shelter, etc. Such plants or animals as possess the most advantageous variation in the struggle for existence will have better chances for survival – this implies a *Natural Selection* where the fittest survive (*Survival of the Fittest*), and perpetuate the race, transmitting the heritable variations to their progeny, while the weakest go to the wall. Darwin's views in regard to the *modus operandi* of the origin of new species have been quoted above. Various modifications have been suggested in this theory as a result of later work, but in essentials the theory, as accepted today, remains as it was enunciated by Darwin.

Whereas the followers of the theory of Special Creation and the immutability of species believed that domestic animals had been created as distinct species, no modern man of science doubts that all our domestic animals are derived, as a result of selective breeding by man, from one species or another of wild animals, and do not represent distinct species.

Domestic animals have been defined differently by various authorities on animal husbandry and domestication of animals. The most comprehensive definition is that of Wilkens as modified by Duerst, according to which one classifies as domestic such animals as are useful to man in connection with his domestic pursuits. In addition, these animals must reproduce regularly in captivity, and must react favourably to the artificial methods of selective breeding as practised by man. This definition excludes several animals which are tamed by man for use in hunting, such as the ferret, the hawk, the falcon, etc., but which do not regularly reproduce in captivity. Similarly the guinea-pig, though it breeds in captivity regularly, is not strictly speaking a domestic animal, as it is of no special value in connection with the domestic life of man and, therefore, the artificial methods of animal husbandry are not applied to it. Such animals as the canaries, parrots, doves and gold-fish, which are often kept as pets, are classified as tame rather than domestic animals.

Amongst the vertebrates the following are the true domestic animals:—

Horse, donkey, pig, camel, llama, alpaca, reindeer, sheep, goat, buffalo, ox, yak, rabbit, cat, dog, swan, duck, goose, fowl, pheasant, peacock, guinea-fowl, turkey, pigeon and doubtfully the ostrich; the last has been domesticated during the last century only.

Here it is necessary to digress to a discussion of the question of when and where man appeared as the dominant animal on the face of the earth.

The Mesozoic era from the Triassic to Cretaceous and lasting for somewhere in the neighbourhood of 150 million years, was the Age of Reptiles. This was followed by the Tertiary era, which is supposed to have lasted for about 50 million years. Mammals, during this era, gained dominance over the reptiles of the Tertiary era, and it is, therefore, generally designated as the Age of Mammals. The Tertiary era was followed by the Quaternary, and this, according to the earlier ideas, signified the first advent of man on the face of the earth: its age, based on the uranium-lead-helium content, is computed at about one million years. Till 1909, the above was generally supposed to be the date of the advent of Man, but the discovery of the Pliocene sub-Red Crag flint beds of the Bramford Dawn Man in East Anglia, England, shifted back this date into the Age of Mammals from the

uncongenial Ice Age into the more genial Tertiary era.

According to the traditional or non-scientific belief the homeland of man was supposed to be somewhere in Western Asia, but the Chinese believe that they originated in Eastern Asia, in China. Quatrefages, on the other hand, had suggested North Asia and Joseph Leidy Central Asia as the original home of man. Matthew in a very remarkable essay on Climate and Evolution (1911) brought forward evidence to show that the centre of dispersal of human race was Central Asia. He remarked that in this region, now barren and sparsely inhabited, are to be found the remains of civilizations perhaps more ancient than any of which we have a record. "Immediately around its borders lie the regions of the earliest recorded civilizations—of Chaldea, Asia Minor, and Egypt to the westward, of India to the the south, of China to the east. From this region came the successive invasions which overflowed Europe in prehistoric, classical and mediaeval times, each tribe pressing on the borders of those beyond it and in its turn being pressed on from behind." The recent work carried out by Andrews, Osborn and their colleagues under the auspices of the American Museum of Natural History has definitely strengthened the Central Asiatic theory for the origin and dispersal of man to other parts of the world.

The Dawn Stone Age or Eolithic is to a certain extent still shrouded in mystery, but the following period, the Palaeolithic or the Old Stone Age, definitely marks the time when man became the dominant animal on earth. It is not possible to compute the date of the Palaeolithic Age, but it was contemporaneous with the Glacial epochs. During this age man took to constructing more or less well designed stone or flint implements for his use. The approximate chronologies of the Palaeolithic, Neolithic, Chalcolithic and Bronze Cultures as set out by various authorities are mainly conjectural and will probably be modified greatly by future discoveries, but there is no doubt about the sequence of these cultures which finally culminated in the Age of Iron; in Central Europe the Iron Age is dated at about 600 B.C. The Neolithic Culture at Anau in Central Turkestan, was dated at about 9,000-8,000 B.C. by Pumpelly who carried out the investigations, but according to Christian, it was somewhat later, *viz.*, 5,500 B.C. According to Duerst, who worked out the animal remains excavated at Anau, the domestication of animals in this area started about 8,000 B.C., but Christian is inclined to put it between 5,500 and 4,500 B.C. The Stone-Copper Age, which followed, was believed to have extended from 6,000 to 4,000 B.C., while the true Copper Age, according to Pumpelly and Duerst lasted from 5,200 to 2,200 B.C. but according to Christian from 4,000 to 2,500 B.C. Sir John Marshall regards the Chalcolithic Civilization of the Sind Valley to be as old as 3,250 B.C., which would make it more or less contemporaneous with the Copper Age of Central Turkestan, Egypt and even of Central Europe. These dates, conjectural as they are, are of very great importance in assessing the probable dates of domestication of animals.

In the earlier stages man undoubtedly was a hunter and lived mainly on fish or flesh of the animals which he hunted. In addition, however, probably the women-folk and the children collected such roots and fruits of wild plants as they found in the immediate neighbourhood of their dwellings. At a somewhat later date, however, man took to agriculture in a very primitive form by cutting up and burning trees and brushwood over level areas, and, having cleared the ground, dug it up with his tools of stone and sowing seeds of corn such as wheat, maize, etc., started agriculture in a very primitive form. The full development of agriculture was not possible till, as Hilzheimer rightly asserts, cattle had been domesticated, or as Hahn definitely suggests, man began using oxen for ploughing his fields.

Our information in regard to the wanderings of the earlier races of man from one part of the world to the other is very limited, but there is very little doubt that the principal races of man migrated from Central Asia which has, therefore, been aptly described as the Cradle of Man. The lines of migration of the various races have been indicated differently by various authorities, and

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in the present state of our knowledge there is little likelihood of a unanimity in this connection. This much, however, is certain that migrations of various races on a large scale were subsequent to the domestication of several classes of animals by man.

It is not easy to determine the exact times and centres of domestication of various animals as the majority of them were domesticated in prehistoric times about which very little information is available. In all countries, however, where the remains of occupation by early man have been discovered, these are accompanied by the remains of domesticated animals.

One of the earliest civilizations, the old Babylonian Civilization which is dated at about 5,000 B.C., shows a fair variety of domestic animals. In the case of the Chinese the domestication of animals, or more correctly animal husbandry, started in the year 3,670 B.C., when the seventeenth king of the ninth dynasty, Fo-hi by name, issued an edict enjoining that the six domestic animals, *viz.*, horse, cattle, fowl, pig, dog and sheep, be carefully tended and bred, which definitely shows that these animals must have been domesticated in China long before this date.

Pumpelly's excavations at Anau in Russian Turkestan brought to light extensive remains of domestic animals, while Hilzheimer has studied similar remains from Mesopotamia.

The animal remains of the Sind Valley Civilization from Mohenjo-daro were worked by Sewell and those from Harappa and other prehistoric sites by Prashad; these confirmed the presence of a large number and variety of domesticated animals in this valley at 3,250 B.C.—the date of this civilization according to Sir John Marshall. It must, however, be noted, that, in view of the fact that the civilization and domestication of animals was already greatly advanced in the Sind Valley at this date, the domestication of animals in this area must have long preceded the 3rd millennium before Christ, the date now generally assigned to this civilization.

The drawings on zinc cylinders and drinking cups of the old Babylonian and Syrian times of about 4,000 B.C. which depict hunting scenes, netting of cattle and keeping them in enclosed areas, seem to indicate that by this time these primitive nations had already started domestication of animals.

In Europe man of the Palaeolithic times already had a number of domestic animals. In the caves and grottos of Palaeolithic times numbers of paintings of various animals including horses with primitive bits and saddles have been found. The prehistoric Swiss lake dwellers of a much later date, who lived in huts built on piles, also had a large variety of domestic animals.

The earlier stages in the domestication of animals are very difficult of interpretation. The various theories advanced in this connection are based on an instinctive attraction of early man towards animals in general. In this connection it is pertinent to note that primitive tribes generally are very fond of animals, whether wild or domesticated, and are known to keep a fair number of them as pets.

Several authorities believe that the religious beliefs of early man necessitated the capture of wild animals which he required for offering on the festivals in honour of his primitive gods and the harvest feasts. This capture probably led to taming and at later date to the domestication of animals. According to this view the controlling factor in the domestication of animals was purely religious.

Some authors, however, maintain that the practical considerations could not possibly have influenced early man to take to domestication of animals, for all such practical uses of these anmials are the results and not the cause of domestication. Early man selected instinctively certain wild animals for domestication, and strange as it may seem, very few animals have been added since that time to the list of animals domesticated during the long era of civilization. This, however, should not be understood to mean that early man was in any way cleverer or specially gifted than the civilized man of the succeeding ages, but it appears that his selection, based on instinct, proved to be very judicious and mate-

rially influenced the advance of civilization in the succeeding ages. Early man could not possibly have realized the economic values of the animals which he selected for domestication, for no primitive intellect, however highly developed, could possibly have foreshadowed the practical uses of the animals selected for domestication. However clever and ingenious early man may have been, he could not possibly have foreseen that at some later date the cows, goats and sheep, which he was domesticating, would yield sufficient milk for his use after suckling the calves or the kids, for, as is well known, the milk yield of the wild cattle, goats or sheep, is barely sufficient for their own progeny. Similarly, he could not anticipate that sheep would provide wool for his clothing, for the coat of the wild sheep consists mainly of coarse hair and only a few woolly hairs are developed during the winter. *Inter alia* it may be mentioned that it was the animal skins rather than clothes made of their wool or hair which served as the covering for early man. Similarly, the horse which proved such an important factor in the advance of civilization in the early stages was not what it is today; its progenitor, the wild horse, was a small animal, absolutely useless for riding and had only a limited utility as a beast of burden; it was not the majestic animal it has developed into as a result of selective breeding by man. It should thus be clear that the reasons of the early man for keeping animals and later domesticating them were entirely different from the utilitarian motives which have been advocated by some authors as the grounds for their domestication. Early man was certainly at its best in the taming of the wolf or jackal cub from which evolved the dog. Using intellectual encouragement in the case of the dog and later the horse he secured for himself and his successors two of the most useful animal companions or, as Sir Arthur Thomson calls them, "true partners." In the case of sheep and donkey and probably goat and cattle he traded on their docility and probably repressibility, while such animals, as the cat and ostrich accepted his domination without losing much of their wildness. Domestication, as Sir Arthur Thomson rightly sums up, "is a lost art, implying patience, sympathy and insight—making friends with animals, young ones to begin with," and in all these qualities the civilized man of the present age is much the poorer as compared to the early man.

Another line of thought is based on the fact that all primitive tribes are fond of keeping animal pets. It is, therefore, suggested that early man took to keeping as pets such animals as he came across during his hunting expeditions and excursions. This certainly appears to be the explanation of how the ancestor of dog became a companion of early man and later developed into his first domesticated animal. In this connection it is also pertinent to mention that wild animals in areas not frequented or only slightly frequented by man are not shy or afraid of him, and it could not, therefore, have been very difficult for early man to capture some of them and adopt them as his pets. In connection with this line of thought the supreme influence of early woman cannot be ignored. She was certainly the tender foster mother of the helpless, lovable young beasts of the forest. Even within recent times among some of the primitive tribes of Oceania the women folk have known to suckle young pigs and other pets on their own breasts-indicating the possible trend of the early days in the taming of such animals.

One of the most carefully worked out theories in connection with the domestication of animals is that of Mücke, who after discussing the ideas of earlier authors such as Rauber, Hahn, etc., comes to the conclusion that wild animals, which were neither hostile to nor shy of early man, were attracted to his dwellings probably by the greater quantity of food available in such surroundings. In this connection he very rightly opines that there can be no question of early man surrounding large herds of wild animals and driving them to his dwellings, but that the animals came of their own free will to such areas. Early man was pleased at these new arrivals and received these animals as his guests; they gradually began to lead a symbiotic life with him. He, however, found that in spite of all care the wild

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animals strayed away into the jungles from time to time. This led to his enclosing them in corrals or enclosures and thereby having them at hand as he required them. Apparently the main factor which helped in connection with the earlier taming and domestication of animals was supplying them with such food as the animals required and this involved the collection of food by man not only for himself but also for the animals he had captured. At this stage of his evolution, early man had long passed the hunting stage and had gradually become primitive agriculturist, having passed through the " gathering " stage, and was probably a vegetarian to a large extent living on roots, plants and such varieties of corn as he grew in his primitive fields. Mücke contends that domestication could not have been accomplished by people in the hunting stage and that in the earlier times the breeders of cattle and the cultivators of soil were two separate entities. He further suggests that the wild animals probably first came to the dwellings of primitive man in quest of food, thereby inferring that these people were agriculturists, for as Duerst rightly points out, ruminants like oxen and sheep could not have been attracted by meat, fish or other products of the hunting and fishing life. Consequently Duerst is of the opinion that the agricultural stage of human development must have preceded that of cattle breeders. Though it is impossible to dogmatize about the exact sequence of events, one would not be wrong in presuming that, whereas in the earlier stages primitive agriculture may have antedated domestication of animals, its further development was not possible without domestic animals.

More recent authors describe the early stages of domestication as having resulted from a symbiosis or the living together of early man and certain animals, each being useful to the other in some ways, but neither being entirely dependent on the other. Duerst, however, pointed out that symbiotic condition of life was possible only in the case of animal pets of early man and not of those animals which he took up for domestication. For the latter the various stages consisted in *(i)* capture, and *(ii)* taming of the animals; while the final stage of domestication was achieved only after the tame animals began to reproduce in captivity. This led to the development of animal husbandry in its true sense. *Inter alia* it may be mentioned that most wild animals do not breed in captivity and it must have due to fortuitous circumstances, as one cannot ascribe it to the astuteness of early man, that all the animals selected by him for domestication were such as took easily to breeding in captivity.

As mentioned above, the earliest companion of man was the dog. Its progenitor, the jackal or wolf cub was found by the hunting man during his expeditions and brought home with him. The various races of dog, which are of mixed origin, are to be traced to the jackal and the wolf, and are the result of careful and selective breeding by man from these ancestors. There was no economical consideration involved in the domestication of dog, but it proved to be early man's most useful companion; with its highly developed brain and intelligence it proved its utility even to the early man as the guardian of his household and goods, and was most useful for hunting and other similar pursuits. The first useful domestic animals of the Eastern Hemisphere were undoubtedly the cattle and these were followed by goats and sheep as the earlier meat and milk-yielding animals. The first animal for transport was the donkey, which was followed by the camel and later the horse. In the earlier stages all of them served for transport and it was much later that they were adapted for riding. With the cattle we have also to include the reindeer which in the northern countries of the Western Hemisphere and in America is of such vital importance to the Eskimos and other tribes living in these ice-covered regions. The only mammal, which was domesticated solely for its flesh, was the pig. All these animals with the exception of the reindeer, occur in the Central Asiatic plain, and it was, therefore, generally believed that they were probably domesticated there. Hahn definitely limits this centre to the country between the Euphrates and the Tigris *i.e.*, Mesopotamia. On the other hand, the more recent discoveries of animal remains at Anau in

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Russian Turkestan and in the Indus Valley indicate that this centre of origin was much larger and probably extended from central Turkestan through Persia, Mesopotamia and Baluchistan to the Sind Valley.

The early history of India is shrouded in mystery and before the advent of the Copper-Stone Age or the Chalcolithic Civilization of the Indus Valley discovered in 1923, it began with the times when the Aryans migrated to India. The exact date of the Aryan advent is not known according to some authorities it was during the latter half of 2nd millennium B. C., while others place it at a much later and impossible date, *viz.*, about 600 B. C. Prior to the Aryans there were the Dravidian-speaking inhabitants of India who also were invaders from outside and who, after overcoming the aboriginal Proto-Australoid inhabitants of India concentrated in the central and southern parts of the Indian Peninsula. As to their ancestry, invasion, and occupation of India we have very little information, but probably they, in their turn, came from somewhere in Western Asia, though according to the beliefs of a primitive tribe they were descended " from a person who at the dawn of time landed from an impossible boat on the shores of a highly improbable sea." If this is correct, they came to India by a sea route and not as the Aryans did at a later date, over the Himalayan passes to the fertile plains of India.

The Indus Valley Civilization, which was apparently preceded by a Neolithic culture, was probably an offshoot of a larger culture which manifested itself along the Afrasian belt of Western Persia and Mesopotamia in the Chalcolithic Age. Mainly centred in Sind, which was a much more fertile region than it is today, this culture extended in the west to Baluchistan and through the Punjab probably north-eastwards into the valleys of the Jumna and the Ganges.

The human remains found at Mohenjo-daro have been classified as belonging to four ethnic types, the Proto-Australoid, Mediterranean, Mongoloid-Alpine and Alpine. The Proto-Australoids, probably the earliest human inhabitants of India, were relicts of the earlier inhabitants, the Mediterranean Region and Western Asia, while the Alpine and the Mongoloid-Alpines migrated into India from Western and Eastern Asia respectively. The question that has to be considered is whether the progenitors of the Indus Valley Civilization were of the Dravidian stock, in view of the fact that the Sumerians, with whom they show such intimate relations, are believed by some authorities to belong to the same ethnic type as the Dravidians. The presence of the Dravidians in the northern regions in remote ages is indicated by the language of the Brahuis of Baluchistan, but the main difficulty of the problem lies in the fact that it is not possible to define precisely the racial type either of the Sumerians or of the Dravidians, both of which certainly represent several mixed types. Further, it is possible that the original racial type of the Dravidians was transformed by their intermarriage with the aboriginal Indians, the Proto-Australoids. In either case, whether they migrated from the West to the East or the East to the West, none of the skulls discovered at Mohenjo-daro have been identified positively either as Sumerian or Dravidian. Several references in the Rigveda to a non-Aryan civilization point to a distinct ethnic type being responsible for the Indus Valley Civilization. This supposition fits in with the now generally accepted view of the date of the Rigveda being not later than *ca.* 2000 B.C.

Our information in regard to the history, life and domestic animals of the Proto-Australoids, the Dravidians and even the earlier Aryans is very meagre; all of them were apparently nomadic people and as very few material monuments of their times have so far been discovered in any part of India, the only sources of the history of these times are the Vedas and other Sanskrit works. In regard to the Proto-Australoids, there is the possibility of their having dog as a domestic animal. The early inhabitants of Australia who probably belonged to the same stock as the Proto-Australoids of India, took with them the Dingo or the Australian dog from the Asiatic continent; this seems to indicate that the Proto-Australoids had domesticated dog at a very early age.

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As stated above very little information is available regarding the domestic animals of the other two classes of inhabitants, *viz.*, the Dravidians and the early Aryans, but excavations at two of the important sites of the Indus Valley Civilization, *viz.*, Mohenjo-daro and Harappa, have brought forth a very rich harvest of animal remains. The remains from Mohenjo-daro were studied by Lt. Col. R. B. Seymour Sewell, F. R. S., and those from Harappa by the author. These studies, incomplete as they are, have thrown a great deal of light on the various classes of domestic animals found at the time of the Indus Valley Civilization. Our sources of information in connection with such animals are twofold: (1) the actual bony remains, and (2) the representations of various animals on seals and other objects such as *terra cotta* figurines and models excavated from these sites. As the animal remains excavated both at Mohenjo-daro and Harappa were not obtained in sharply marked off strata or in successions at relatively distinct depths, it is impossible to construct a hypothetical sequence for the appearance of the various species of animals such as was attempted by Duerst for the Central Asiatic forms excavated at Anau. There seems little doubt, however, that of the various domestic animals found in the Indus Valley sites several are probably the descendants of the very rich mammalian Siwalik Fauna of the Indian Tertiaries. For example, the Indian camel and buffalo are so closely allied to the Siwalik forms that their ancestry cannot be doubted, while most recent authorities are also agreed that the Indian humped cattle and the short-horned cattle found in the area are the descendants of the Siwalik Nerbuddah Ox.

My views in regard to the various types of domestic animals, which have been found at Harappa, may be summarized as follows:—

Cat. Sir John Marshall stated that the cat was not known to the inhabitants of the Sind Valley, as no remains of this animal were found at Mohenjo-daro. In the collection of animal remains from Harappa, however, there are a number of bones of the cat excavated at depths of 3′ 10″ to 5′. These remains are well preserved and appear to be fairly ancient. Though it would be rash to assign them definitely to any particular age, I am of opinion that they are contemporaneous with other animal remains found at Harappa. There is a general consensus of opinion that the ancestor of the domestic cat was the African *Felis ocreata* Gmelin, and the Indian domestic cat which is to be derived from this ancestral form, was imported into India probably with such other domestic animals as the donkey.

Dog. Sir John Marshall from the *terra cotta* figures of the dog and a finely carved steatite figure of a hound excavated at Mohenjo-daro concluded that there were probably two distinct types of dog domesticated by the Indus people: (1) a type akin to the Pariah, and (2) a more highly bred dog allied to the modern mastiff. The only remains of the dog from Harappa are the bones of a dog of the greyhound-type, with an elongated snout. I consider this type to be allied to *Canis tenggearanus* Kohlbrugge, which had a wide distribution in the Oriental Region in the Diluvial times, and was the ancestor of the Pariah dog. Through domestication by man the greyhound, the Tibet dog and probably other races of dog were evolved from it. The Harappa dog, for which I have proposed the name *C. tenggeranus* race *harappensis*, shows in the shape of its skull, distinct affinities with the Indian wolf, *C. pallipes*, and so far as can be inferred from the scanty remains available, it was probably the ancestral form of the Indian greyhound. The dog was apparently domesticated in the Indus Valley at a firstly early date.

Ass. I consider the domestic ass, the remains of which have been found at Harappa, in view of its close relationship with the African species, to have been imported to the Indus Valley from Africa, probably along Jacobi's Arabian and Persian Region of Dispersal.

Ox. Two types of cattle— the humped (Zebu) and the humpless—can be distinguished in the representations on seals and other objects found at Mohenjo-daro and Harappa. I agree with Duerst that the short-horned, humpless type originated as a result of the decline of cattle-breed-

ing in the Valley from the long-horned, humped cattle, and is not to be considered as a new race which was imported from outside. The long horned humped cattle I consider to be the descendants of *Bos namadicus* Falconer and its earlier progenitor *B. primigenius* Rütimeyer of the Siwalik Fauna.

Buffalo. There is a general consensus of opinion that the Indian buffalo is the direct lineal descendant of the gigantic *Bubalus palaeinidicus* Falconer, of the Pliocene Age, and I am of opinion that one of the centres, if not the sole centre, of its domestication in India was the Sind Valley. Unfortunately very few remains of this animal were recovered from either Mohenjo-daro or Harappa, but even with this material there can be no doubt that this animal, as Sir John Marshall also suggests, had been domesticated by the Indus Valley inhabitants.

Goats. The ancestry of the Indian domestic goats is somewhat uncertain, but they can provisionally be considered as derived from the Pasang *Capra aegagrus* Gmelin, and probably the inhabitants of the Indus Valley played an important part in the domestication of this animal.

Sheep. With our present knowledge of the domestication of the sheep it is not possible to dogmatize about the origin of the various races of the Indian sheep, but the Urial, *Ovis vignei* Blyth the range of which extends to the Indus Valley, is probably the ancestor of the domestic sheep found at Mohenjo-daro and Harappa.

Pig. The Indian pig, *Sus cristatus* Wagner, which is closely allied to the widely distributed species *S. vittatus* Müller & Schlegel, was probably derived from the *vittatus*-stock. The domestic pig found in the Indus Valley may have been domesticated from the wild boar common in this area or might have been imported from the adjacent regions.

Camel. The Indian one-humped camel is undoubtedly the descendant of the Siwalik fossil form, *C. sivalensis* Falconer and Cautley, and there seems every reason to suppose that the domestication of this animal was first brought about in India and probably in the Indus Valley.

Blanford writing in 1877 remarked, " It has long been known that we are probably indebted to the early inhabitants of India for two domestic animals, the buffalo and the peacock; the origin of the humped cattle is obscure, and the common fowl appears to be descendant of the Burmese and not of the Indian race of the wild fowl." Jeitteles, however, suggested that some of the most valued races of European dogs are of Indian origin. In view of the recent discoveries regarding the domestic animals of the Indus Valley Civilization it would not be far wrong to consider India as having been a very important if not the sole centre for the domestication not only of the buffalo, but also the dog, the cattle, the sheep, the goat and the camel.

In conclusion it is sad to note that in India very little attention has so far been paid or is being paid to the study of domestic animals. In spite of the great deal of attention which animal husbandry has attracted within recent years, our information in regard to the various indigenous breeds of cattle, sheep, goats, horses, dogs, etc. is very limited. Until detailed information on these points is available, the conservation and breeding of pure races of any one of these animals is out of question. Let us hope that as a result of the keen interest which His Excellency the Viceroy takes in the progress of agriculture and allied problems, animal husbandry will receive the attention that it merits. For the advancement of human culture and civilization, domestication of animals was of just as great importance in the earlier stages as the discovery of steam power and electricity at a later date, while for a primarily agricultural country such as India the importance, even at the present day, of the domestic animals in regard to agriculture and the general life of the people cannot be overestimated.*

Lecture delivered at Allahabad on the occasion of the Golden Jubilee of the Allahabad University.

Sir Arthur Stanley Eddington

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WE are fortunate to have in our midst this afternoon Sir Arther Stanley Eddington, one of the greatest living scientists of the present times. The ancient city of Allahabad—Prayag of epic name which flourished even in 2000 B. C. when Vedas were composed, is famous for its Sangam or confluence of two mighty rivers—the Ganges and the Jumna. The combined waters of the two streams then rush on through the Gangetic plane to the Bay of Bengal fertilizing vast tracts of land and providing food and happiness to millions. It is in the fitness of things that the ancient city of two rivers should welcome the eminent scientist in whom two important branches of knowledge—physics and astronomy—have combined with such happy and fruitful results in unfolding the mysteries of the Universe. Indeed it is hardly necessary to mention that Sir Arthur Eddington is one of the foremost astrophysicists of modern times.

Early Career

After a very distinguished career at Cambridge, Eddington was appointed chief assistant at the Royal Observatory at Greenwich in 1906, two years after he had graduated as senior wrangler. He remained at Greenwich till 1913 when, at the young age of 31, he was appointed Plumian Professor of Astronomy at the Cambridge University in succession to Sir George Darwin. I had the privilege of being one of his pupils at Cambridge. In 1918, my friend, Dr S. N. Savoor, and I used to go to the observatory at night and work there under Professor Eddington. I remember that during the Easter term of the same year, we attended a course of lectures on "Generalized Relativity" which he gave for the first time, and these were, I believe, the first lectures on Generalized Relativity in England.

To form an estimate of Eddington's contributions is no easy matter. *There is hardly any branch of astronomy and astrophysics which he has not touched and whatever he has touched he has left in a much fuller state.* When he started his investigations, now nearly 30 years ago, astrophysical knowledge was rather in a confused state. Astronomers knew about the extent of the Solar System and were also aware of the fact that the sun was only one of billions of stars forming the Milky Way. The distances of a number of nearer stars in the Milky Way were known, but there was no precise idea regarding the composition, extent, and dimensions of the Milky Way. The relations of the Milky Way to other prominent galaxies and star groups like Andromeda nebula and Magellanic clouds was entirely unknown. In fact, the geography of the heavens was still in its infancy.

On the physical side, thanks to the discovery of spectrum analysis by Kirchoff in 1858, the new science of astrophysics has grown up, which has for its object the investigations of the physical state of stars from a study of their spectra. An extensive study was made of the spectra of stars and some conclusions were drawn therefrom regarding their composition and temperature, but the star was still regarded as a diffuse mass of gas held together by only gravitational forces and appearing on account of distance as a mere point of light. It was at this stage that Eddington entered the field of investigation.

Early Studies of Stellar System

The Dutch astronomer, Kapteyn, had suggested from the proper motions of the nearer stars that there were two favoured directions in which the stars were streaming. Eddington carried out independent investigations and found that stars were not wayward children of a parent nebula having random motions, but were more or less

moving in two distinct directions. He also found that there was a third small drift of much less importance than the other two. In 1914, Eddington wrote his book, *Stellar Movement and Structure of the Universe.* It is well known that since then the subject of the exploration of the Universe has made very substantial progress due to the works of Shapley, Lundmark, Lindblad, and Oort. The Milky Way to which we belong has been found to be a lens-shaped body about 30,000 parsecs in diameter and 3,500 parsecs in thickness. The Solar System is about 10,000 parsecs away from the centre. The Milky Way has been found to be revolving about an axis directed towards a point in the Sagittarius Star cloud with a period of 2×10^8 years. Eddington's early studies substantially helped us in the attainment of the present knowledge.

Internal Constitution of Stars

The problem of the equilibrium of stars as gaseous masses under gravitational forces and obeying perfect gas laws was studied extensively by Emden early in the present century, but his investigations failed to receive observational confirmation owing to the neglect of physical factor destined to play a great part in Solar Physics. Eddington was the first to appreciate the importance of radiation pressure in the stellar structure, and this enabled him to lay the correct foundations of the internal constitution of stars. Eddington showed that the problem of stars could be handled properly only if a number of physical factors which had so far been ignored by the mathematicians were included. These are (1) the pressure of light which, though very small under ordinary conditions, becomes large at the high temperature prevailing in the inside of stars, (2) the equation of Radiative Equilibrium involving the opacity factor, *i.e.*, the capacity of matter to allow radiation to flow through them. But with reasonable assumptions, Eddington was able to work out results regarding the relation between mass and luminosity of stars, which still holds the field for the main sequence of stars.

In the case of giant stars, he was able to form an estimate of density, and thus of the size of these stars. Up to this time, their diameters could not be measured. But in 1921, Michelson and Pease, with the aid of the 100″-telescope of Mount Wilson Solar Observatory were able to measure the diameter of the red giant Betelgeuse in the Orion group. It was found that it had dimensions which were predicted by Eddington.

Eddington's contributions to stellar structure have not, however, gone unchallenged. His assumptions regarding validity of the equation of state, opacity factor, and boundary conditions, and his ignoring the internal source of energy have been matters of acute controversy between himself and Jeans, Milne, Nernst and others. But these controversies have raised points about which wide divergence of opinion still prevails and for precise information, perhaps we have still to wait for further developments in physics. But Eddington will always be remembered as the pioneer who started this line of investigation.

White Dwarfs

Eddington was the first to point out the existence of the remarkable stars now known as White Dwarfs, where matter may be 100,000 times denser than water. This was obtained from a study of the dark companion of Sirius, which has a large mass, but a very small luminosity and a very high temperature. All these taken together, as Eddington showed, point to an extraordinary conclusion, *viz.*, matter in this star is 60,000 times denser than water and 3,000 times denser than platinum, the densest material known to us on the earth. The hypothesis was put on a sure foundation when Adams in 1925 found that *H*-lines on this star were shifted by a very large amount equivalent to 19 Km per second towards the red, as predicted by Eddington on the basis of Einstein's theory of Relativity.

The discovery of White Dwarfs, and of the possibility of the existence of matter in an extraordinarily high state of condensation are events of outstanding importance in physics. Many young workers of our country are now carrying on investigations on this line amongst whom I would mention Chandrasekhar who has worked on the degenerate state of matter* inside stars, and Kothari and Majumdar who have developed a

theory of pressure-ionization inside these bodies. They have thus carried further the work started by Eddington.

Coefficient of Opacity

Eddington considered for a number of years as to how the brightness of star would be affected by the opacity of its material. For several years he was unsuccessful in getting the numerical value of the absorption coefficient. He worked out the theoretical formula expressing the law of dependence of absolute magnitudes of a star on its mass, but it was necessary to know one pair of corresponding values in order to anchor the formula so that the coefficient could be numerically found. Ultimately Capella, which is the only giant star for which both the mass and luminosity are known, supplied the clue. Eddington thus obtained a value for the coefficient of opacity which however does not agree with the theoretically deduced formula by Kramers. However this matter has not yet been definitely settled. Moreover Kothari and Majumdar have shown that the coefficient of opacity cannot be constant.

Generalized Theory of Relativity

Eddington's attention was first drawn to Einstein's theory of Relativity by De Sitter's three papers in the *Monthly Notices* in 1916. He then made a systematic study of the theory and was first to draw public attention to the fact that the theory could be tested by observing the deflection of rays of light from a star which would graze the sun at the time of solar eclipse. In 1919, Eddington himself led one of the first two eclipse expeditions which were sent out to test Einstein's theory and was the first to obtain observational confirmation of the gravitational deflection of light. On the purely theoretical side, Eddington has generalized Weyl's unified theory of the electro-magnetic and gravitational fields. He has developed considerably the theory of Relativity and his researches and efforts have stimulated considerably the study of the theory of Relativity.

Eddington is responsible for giving wide circulation to Le Maitre's papers regarding the expansion of the Universe and in fact showed that the Einstein Universe is an unstable one and that a slight disturbance will cause the Universe either to expand or to contract.

Le Maitre concludes from the red shift of spectral lines in the light received from distant nebulae that the galaxies are receding with velocities proportional to their distances from us and the Universe is expanding. But one may reasonably ask, what will happen when the velocity of recession becomes equal to that of light? Perhaps the bubble of the Universe will burst, and the different pieces will form separate universes receding from one another with velocity greater than that of light, and no light would be able to pass from one piece to another. Again, can we think of " Void " apart from " Space," so that the Universe which now pervades " Space " is expanding in ' Void '? Perhaps we may differentiate between " Void " and " Space " by postulating that in " Space " geometrical laws hold good, whereas in " Void " no such laws are possible.

Eddington has calculated that the Universe is doubling itself in every 1400 million years. At such a rate the distances of the spiral nebulae would have increased 7 times over in every 10,000 million years, and they would become fainter by ten magnitudes. If this be actually the case, we are very fortunate that we are still able to see remote extragalactic nebulae. But we have to admit that " time scales of cosmic evolution are at present hopelessly contradictory," for the geologists require a time scale for changes on the Earth's crust which is much larger than 1,400 million years. So naturally a reasonable doubt may arise as to whether the reddening of light from nebulae can correctly be interpreted as a velocity of recession. It has been suggested that the red shift is caused by the loss of energy in the photon in the course of time due either to inherent instability or some cause, *viz.*, collisions with other photons. It has also been suggested that the Universe might have been oscillating for a sufficiently long time and that at the present moment it is in the process of expansion. Recently there has been a good deal of discussion between Eddington and Hubble concerning the tenability of the theory of Expanding Universe. I feel that the point is still undecided, and should not make any observations on this controversy.

Recently the General Theory of Relativity has been put to a very severe test. Dr Evershed, from his observations, has come to the conclusion that " in the red, the limb effect is nearly equal to the Einstein effect," *i.e.*, the total shift at the limb of the sun is probably twice the Einstein effect. As consequence of observations made at the last eclipse expedition, Dr. Royds has found that there is decidedly a marked and progressive increase in the shift from the centre of the sun towards the edge. I may mention here that Sulaiman has deduced a formula from his theory which gives a progressive increase in the shift from the centre towards the limb and the value at the edge is found to be twice that at the centre.

Relativity, specially the General theory of Relativity, is on its trial now. We wonder if Eddington will take up the brief for the defence and establish the validity of all the claims so far made by Relativity.

Among the workers in the field of Relativity in our country I may mention the name of N. R. Sen who worked out the case of " the pimply Einstein world " which could also be in exact equilibrium. He also gave reasons why cosmic repulsion gets the upper hand when matter in the original uniform world of Einstein is re-arranged in condensations. Narlikar has also suggested that cosmical constant λ is not an absolute constant but is a function of time, and by this assumption he has explained the expansion of the Universe as being due to condensations.

Relativity Theory of Fundamental Particles

Matter appears continuous to our gross senses and in the usual theory of Relativity it has been treated as continuous. Experiment has shown that matter is composed of groups of unit and so led to the formulation of quantum theory. Eddington felt that efforts should be made to unify or harmonize Quantum Mechanics and Relativity. This has been attempted by Dirac by his relativity theory of the electron, but it is well known that Dirac's equations cannot be expressed in tensorial form. Eddington wondered why Dirac's type of invariance should elude ordinary tensor calculus. Ultimately Eddington introduced new Wave-Tensor-Calculus to bridge the gulf. It may not be out of place to mention here that Van der Waerden also tried to solve the difficulty by introducing " Spinors." In physical applications to his new Tensor-Calculus Eddington has tried to ascertain the conditions which fix the amount of mass and electric charge carried by protons and electrons. His theory has led him to assign the exact value 137 to the Sommerfeld fine structure constant. He has also been able to tell us that the number of protons and electrons in the Universe is $2\times136\times2^{256}$ *i.e.*, about $3\times15\times10^{79}$. The child is the father of the man, and as has been stated by Whitaker, at the age of four, Eddington resolved to count all the letters in the Bible. Eddington has obtained 1847.6 as the ratio of the masses of proton and electron. This is somewhat higher than the value accepted at present. From his theory, Eddington has predicted the existence of negatrons or negative protons. He frankly admits that atomic nuclei and free neutrons are outside the scope of his present theory, but hopes that they will ultimately fit into his theory. But other fundamental particles complicate matters and it is yet to be seen how they would fit in with Eddington's theory. If Eddington's theory is ultimately accepted then he will be classed as one of the great seers of the world. Whatever may be the ultimate fate of his theory, as the founder of the Wave-Tensor-Calculus he will rank as one of the great mathematicians of the world.

Theory of Formation of Absorption Lines

In his studies on the Internal Constitution of Stars, Eddington had to postulate about the mean molecular weight of stellar matter. He assumed that on account of high temperature, matter inside stars is completely broken up into ions and electrons, so that the mean molecular weight slightly exceeds 2. This postulate excited our friend, Prof. M. N. Saha, then scarcely out of his student career, to postulate his theory of ionization of atoms by heat, and thus in the language of Sir James Jeans, " to unlock the road to vast new fields of astronomical knowledge".

As is well known, Saha's theory enables us to form an estimate of the temperature of the outer atmosphere of stars from the presence and strength

of Fraunhofer lines in their spectra. But the form and intensity of these lines is a rather complicated affair. Continuous radiation pours in from a hypothetical photosphere and is absorbed by atoms and ions in the atmosphere in the proper wavelength and appears as Fraunhofer lines. An examination of the strength and contour of these lines would therefore yield us the necessary information about the composition of stellar atmosphere, provided the results could be properly interpreted. Eddington was one of the first to work out a mathematical theory of the formation of Fraunhofer lines, and though the problem is still far from solution, his analysis has not yet been surpassed. Every subsequent theory must proceed from the groundwork constructed by him.

Interstellar Lines

Another brilliant contribution of Eddington which has received much less attention than his other spectacular contributions, is his explanation of the origin of the interstellar lines. In space, we see "Stars", but is the space between one star and its neighbour, entirely bereft of all matter? Eddington, in a Bakerian lecture to the Royal Society, answered this problem. It was discovered in 1904, that certain double stars show a number of lines, e.g. the *H.K*-lines of Ca^{+} which do not take part in the motion of stars round each other, but are absolutely stationary. Some thought that this pointed to the existence of a stationary atmosphere round the star, but Eddington by a masterly analysis showed that the intensity of the lines increased with the distance of the stars. This points out the existence of calcium in interstellar space. He gave an estimate of the density of matter in interstallar space, discussed the reactions between light and matter occurring there, and so laid the foundations of interstellar astronomy. The work is of great significance for all future knowledge of interstellar space, as is revealed by further works of Beals, Dunham, and others.

The above is only a short sketch of Eddington's researches in different fields of astronomy and astrophysics. His is a great mind, grappling with the mysteries of the Universe, and his contribution to positive knowledge is scarcely equalled by any of his contemporaries or predecessors. His work has inspired others, with happy results, many of them are to be found amongst our own country men, *viz.*, Saha, Kothari, Chandrasekhar, Majumdar, and Narlikar.

My object was to say something about the contribution of Eddington to science. But I cannot finish without referring to very fine qualities of Sir Arthur Eddington. I mean his sense of humour which is so rare and his fine literary style which has brought modern scientific thought almost to every home where English language is spoken or read.

* A lecture delivered at the Physics Lecture Theatre of the Allahabad University on the occasion of the visit of Sir A. S. Eddington to Allahabad on Dec. 26, 1937.

A Review of the Plant Hybridizing Work done in India

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VERY little work has been done on plant genetics in India and for theoretical conceptions underlying the practical aspects of the subject we have to depend on the work of Europe and America. Only recently the Agricultural Research Council made a substantial grant to finance a research scheme in plant genetics. However in the improvement of the plants India stands second to none. There is no country in which greater economic results in plant breeding have been obtained, nor perhaps which has better equipped experiment stations for such investigations. The monetary gain from the improved varieties in India alone has been considerable.

In India there is a mess of varieties of a crop so that the crops are always mixed. Very little attempt is made to separate the varieties of the plants. Even when very good new varieties have been produced there is a danger of cross fertilization with inferior qualities and seeds from agricultural centres must be supplied to the grower, if not every year, at least frequently.

Wheat occupies about 24,000,000 acres in India. High-yielding, rust resistant, cross bred varieties with good milling and baking qualities have been produced through the indefatigable labours of Dr and Mrs Howard and others. Wheat of a very fine quality has been produced and is being grown over a large area. Pusa "107" was produced at the Agricultural Show at Sydney and followed with a difference of half of a mark by "Pusa 4." This was selected by Dr. A. L. Humphries, a former president of the National Association of British and Irish Millers. He considered it to be as good as any wheat produced in the world and selected it as his first choice of all Indian wheats for bread-making purposes.

No less than 50 series of improved Indian wheats have been produced. "Pusa 52," a cross between Punjab 9 and Pusa "6", combines the high yield and bearded nature of the former with rust-resistance of the latter.

"An important new production is Pusa 111. This wheat has been grown at Pusa and in Sind under dry and irrigation conditions respectively and has successively subjected to milling and baking tests in England in comparison with other Indian wheats and with Canadian wheats."[1]

The Punjab Agricultural Department has recently completed a series of tests on a new improved variety of wheat grown in the province known as "Cross 518." The variety is stated to be the best of all other kinds grown so far in the province, under the same conditions of soil, fertility and water supply. It is stated that in the last season a cultivator realized a record yield of 49½ maunds of grain per acre from this sort.

A new wheat variety, Pusa 165,[2] (a hybrid between the Australian Federation and Pusa 4 wheats) has given high outturns at Pusa, in the U. P. and in the eastern Punjab, and marks a distinct achievement of the Imperial Department of Agriculture. This wheat is likely to replace the existing wheat varieties in many wheat-growing tracts of India.

The important types produced in India have already benefited the country considerably. 25,00,000 acres are being planted with improved types every year. The gain per year from improved varieties of wheat in India alone is estimated to be about 11 crores of rupees.

1. McRae N: On Imp. Inst. of Agric. Research, *India and the World*, p. 265, 1933.

2. The scientific reports of the Institute of Agricultural research, Pusa 1934-35.

A REVIEW OF THE PLANT HYBRIDIZING WORK DONE IN INDIA

"Important as the results are these results have not been so much availed of by the uneducated and conservative Indian peasant. If the spread of new varieties of Pusa wheat is compared with that of Marquis in Canada and the Northern States of the Union, we realize the fact. In fifteen years Pusa wheats have covered a little over 2,00,000 acres. In about the same period the area under Marquis has exceeded 20,000,000 acres."[3]

Rice is the most important crop and covers about one-third of the total cultivated area. Beale[4] did the most useful work in the classification of rice found in Burma and Mitra[5] in collaboration with Gupta and Gangoly worked on colour inheritance in rice.

So far attempts to produce good hybrids of rice have not met with so outstanding success as in wheat. The matter is receiving the attention of a number of workers.[6,7] Breeding work is at progress at Kajrat, Dacca, and Coimbatore. Bengal Agricultural Department has produced a true breeding variety which flowers and fruits two to three weeks earlier than the pure line types. Thadani[8], working at Sakrand, made crosses between selected strains and other varieties possessing high tillering and large number of grains in the earhead to obtain further increase in yielding capacity.

Until recently, the Bombay Agricultural Department had still on hand the problem of evolving a type of rice possessing fine grains combined with high yield and early maturity which would replace the mid-late coarse-grained varieties extensively grown at present. Further selection within the local Kolamba rice was found to be of no avail in this direction. Hybridization was the only alternative.

Although many crosses were made, only one of these, namely, between a late, fine-grained and high-yielding Kolamba strain, K. 226, and a mid-late, coarse, but long-grained Kolamba, K. 164, yielded the desirable combinations. From this cross two promising fine grained cultures were obtained. Of these, one proved consistently high yielding and competed successfully with the bold-grained rice in this respect. The strain has been designated K. 540.

The field trials of K. 540 in Thana district proved a great success from the very beginning and the cultivators adopted the new variety without hesitation. During the last three seasons (1933-34-35), it has been compared at various places with mid-late large grained varieties such as Dodki, Dangarwel and Patni and has given an average of 2,385 lbs per acre, as against 2,262 lbs of the local varieties. Its highest yield was 2,688 lbs and its lowest 1,990 lbs per acre.

The strain is now spreading rapidly in the two districts of Thana and Kolaba. Preliminary field trials in Gujerat, Ahmednagar and Ratnagiri districts indicate that K. 540 may also prove a valuable variety in those areas.

Oats: Two Pusa selections crossed with Abundance and Scotch Potato varieties of oats have produced very encouraging hybrids as regards higher yield and better quality as compared with local varieties. Here the good grain and strand quality together with the heavy tillering power of imported varieties (European types) have been combined with the earliness and disease resistance of the Indian parent.[9]

Jowar (Sorghum Vulgare) is a very important food crop. In the Bombay Presidency it is grown both as a Kharif and Rabi crop. In dry region of the Presidency (Sholapur, Bijapur and Ahmednagar) and other parts of the country it is the main crop to furnish food to human beings as well

3. Howard A & Howard G L. C. *The development of Indian Agriculture* OX U. P. 1929 Howard, Gabrielle, *Agr: Jour. of India*, Vol XXIV Part III May 1929 (Pres. Address to the Agric: Sec: 16th I Sc Congress, Madras. Jan. 1929).

4. Beale R. A. Agri. Research Institute, Pusa. *Bulletin* No. 167, 1927.

5. Mitra: *Memoirs of the Dept. of Agri. in India* XV No 4 1928 Botanical series.

6. Bhide R. K., *Agricultural Journ. of India*, Vol. XX p. 28, 1923.

7. Ramiah: *Agricultural Journal of India*, Vol, XXII p. 17, 1927.

8. Thadani, K L., Progress of Rice Breeding in Sind. *Proceedings* of the I. Sc. Congress: (Agr: Section) 1929.

9. Shaw F. J. Scientific reports, Agric: Research Institute, Pusa 1928.

as cattle. The Bombay Department of Agriculture started scientific research on the improvement of Rabi Jowar at Mohol in 1930. It has now been possible to evolve a few promising high-yielding strains, namely 35-1, 47-3 and 14-9 in the Maldandi (loose type of earhead). Every effort is being made to spread these varieties as the new strains give 15 to 25 per cent greater yield than the local varieties.

The Royal Commissioners in their report[10] deplored the fact that the Agricultural Department of India was still at the beginning of the work on improving Jowar and other millets.

Sugarcane: At the Imperial Sugarcane Research Station, Coimbatore, valuable results through hybridization have been achieved. Several new varieties have been produced by crossing with *Saccharum Spontaneum* L. as one of the parents. It may not be out of place to mention that it was Dr Barber who first deliberately used *Saccharum Spontaneum* for crossing with sugarcane. Thousands of plants[11] have been raised of which a few notably Co.205, Co.213, Co.290, Co.312, Co.313, Co.331, Co.393, and Co.299[12] have been widely distributed in United Provinces and in North Bihar. Coimbatore canes are being successfully reared outside India as well, especially in Cuba and Florida. A communication from Florida to R. S. T. S. Venkataraman states that in spite of rather difficult conditions of soil and climate " it looks as if Co.281 cane would be one of our best if not our very best cane."

Almost all important characters have been studied and large number of crossings made to improve the various characters. A cross between Vellai Indian cane and *Saccharum Spontaneum* resulted in doubling the average weight of seedlings at harvest. Tillering has been improved by suitable crosses and double the number of seedling producing varieties have been produced. Cross (Vellai Co.292) produced 23 seedlings (usual capacity 12 seedlings).

Characters of root (depth penetration through stiff soil and resistance to water-logging and the thickness, length and shape of the internode) have been improved to a very great extent.

Hybrids with *Saccharum Spontaneum* L. have been noticed to be generally immune to smut, which is otherwise a common disease in Indian canes. Quality of juice (resulting in the greater percentage of sucrose in juice) has been improved. Other characters as habit of plant, inheritance of ivory markings on joints have been crossed to advantage.

Astounding results have been obtained by R. S. Venkataraman in producing early maturing varieties by crossing sugarcane with juar (Andropogon Sorghum) as one of the parents. 7 hybrids Co.351, Co.354, Co.355, Co.356, Co.357 have been produced. More crosses are being made. These hybrids tend to come to maturity in six to seven months from the time of planting and maintain a high quality of juice. Successful hybridization of sugarcane and bamboo has recently been accomplished by R. S. T. S. Venkataraman, Imperial Sugarcane specialist at Coimbatore. The parent plants differ in growth and other characters and the achievement is remarkable in the history of plant breeding. These hybrid plants which are under intensive study to confirm their hybrid nature are only a few months old. Though there are obvious possibilities, it is stated that it is not possible at this stage to foresee the economic advantages which might result from the hybridization. Should the qualities of sugarcane and bamboo combine, this newly evolved plant must be capable of growing even in the driest land. Since bamboo has small branches, in the new hybrid the world will be provided with sugarcane with branches!

Cotton: The bulk of the cotton comes from black soil areas of the Peninsula where the growth period is short as the cotton is raised on the natural rainfall. The conditions exclude a long staple and favour rapidly maturing varieties. Here the problem was to increase the yield per

10. *Report of the Royal Commission of Agri. in India*, Calcutta 1928.

11. Venktaraman R. S. T. S., *Agric. Jour. India*, XXIII p. 170, 1928.

12. *Loc. cit.*

acre. Patel[13] (1919-20) crossed Broach Deshi (1027 A.L.F. and I.A. Cylindrical boll) and E 5 cottons, all strains of *Gossypium herbaceum*. The Gohari crosses provided a considerable amount of interesting material relative to their behaviour in crossing.

Kothar[14] of Bombay has tried to produce a long stapled and high ginning hybrid. A strain of kumpta with a low ginning percentage 20 and a long staple (1″) was crossed with a strain of Neglectum Rosea with a high ginning percentage (36) and a short staple. The cross resulted in true breeding strains which combined the desired characters of both parents. In 1920 Kothar[15] crossed a pure strain of Dharwar American with the Sea Island cotton and found it possible to produce the same quality of lint as Dharwar American but of sea Island quality.

In Gujerat, in Southern areas of the Bombay Presidency, in Hyderabad and in parts of Madras the natural conditions enable a larger staple to be grown. The improvement of the fibre is a much more important matter here. Much has however to be done towards production of a long stapled cotton with maximum ginning percentage. At present three-fourths of the cotton grown in this country is long stapled. Trought[16] and others have considered a rearing of successful cotton hybrid more difficult than in other crops. Thadani[17] made crosses between 4 F and Mead with the object of improving the staple (7/6″) of 4 F cotton which seems to be the hardiest and most prolic cotton for Sind.

Tobacco: The work of cross breeding tobacco is carried on at Pusa (Now New Delhi) and many promising results have been obtained. More than 51 types of *Nicotiana tobacum;* and 20 types of *Nicotiana Rustica* L. are in pure culture. Hybrid No. 142 (a cross between pure deshi Pusa type 28 and an American Adcock) is more suitable for export than the heavy dark type of leaf ordinarily. It has established its reputation as a suitable cigarette tobacco for India.[18]

Groundnuts: New rapidly maturing, disease resistant types of groundnuts were introduced in the early part of this century. The damage caused by the so called tikka disease is out of question now. Several resistant types of pigeon pea have been isolated at Pusa. A close study of the linseed with a view to producing a strain of good yielding power and high oil content is in progress.

Barley: Some cross-bred forms show promise of combining the high yielding of type 21 parent and the white colour of the seed of the other parent and may thus furnish material for producing a good type of malting barley. Wilt resistant rahar, and high yielding hemp and gram are also some of the achievements of the workers at Pusa. Balaji Rao[19] observed partial sterility in the first generation plants of the cross betwen varieties of common egg-plant (*Solanum melongina*).

Linseed breeding received impetus under tariff preference (Ottawa Agreement) and work has been started at Poona, with the aim of improving oil percentage and increasing the iodine absorption number. The quality of the oil has also to be improved.

13. Patel, M *Memoirs of the Dept. of Agr: in India*, Botanical series XIV No. 4, 1927.

14. Kothar, G. L. *Memoirs of the Dept. of Agri. in India*, Botanical series XII p. 71, 1923.

15. Kothar, G. L. *Agri: Journal of India* XX III 1925.

16. Trought: *Agri: Journal of India*, XXI p. 310 etsegmith Biligraphy.

17. Thadani, K. L. *Progress of the Cotton Research in Sind.* Paper read before the Agri: Sec., Indian Sc: Cong: 1929-30.

18. *Loc. cit.*

19. Balaji Rao, *Current Science*, Vol. II, p. 285, 1934.

Bihar Electrification Scheme

B. B. Ray

Introduction

THE probable reserve of Indian coal has been estimated at about 79,500,000,000 tons. Out of this total a good proportion is obtained from the Province of Bihar. On comparing the total generated output of electrical energy in different provinces in British India it is found, however, that so far as the production of electrical energy is concerned Bihar is far behind Bombay and United Provinces where the source of power generation is chiefly hydro electric, Bengal where the source is mainly coal and Madras where both coal and water power is used. It is thus evident to an observer that there is scope for development in this direction in the Province of Bihar. On a first glance one is apt to think that coal only should be used for power generation but on a closer observation it will be evident that ample water power is available and it will be profitable to harness this energy in spite of its proximity to coal fields.

Location of Power Sources

The river Damodar flows through the heart of the province and the valley of the river is one of the richest in coal and other mineral deposits in India. To the north of the province, *i.e.*, in Bihar proper there is hardly any coal and very little water power is available except in the districts adjoining Nepal where there are a number of small waterfalls which afford local power generation for lighting supply. In Chotanagpur there are a large number of waterfalls which can be harnessed and in addition to the water power coal is plenty. Out of a large number of waterfalls in Chotanagpur the following may be harnessed for generation of electrical energy:

(1) Rajropa at the junction of Damodar and Vera rivers. This is essentially a low head fall and being in the centre of the coal mining district will not be worth harnessing in the immediate future.

(2) Hundru Falls on the border of Hazaribagh and Ranchi districts has a good head with a fair amount of water supply and is certainly worth going into. With a scheme of successive developments of a number of reservoirs to store the annual rainfall it will be possible to obtain a continuous discharge of nearly 200 cusecs, equivalent to a continuous output of 6000 kW ex generators.

(3) Jonha Falls in the Ranchi district has a head of nearly 120′ and is within 12 miles of the Hundru Falls. This affords a further reserve of power when the Hundru Falls is fully utilized.

(4) Dumargarhi Falls also in Ranchi District; this is, however, small and is not worth considering in the near future.

(5) Dassom Falls in Khunti sub division can be used for local generation for lighting and small power plants like lac factories or irrigational purposes.

(6) Hirni Falls in Singhbhum Division can be considered in the 2nd programme of Bihar electrification scheme.

As already mentioned above most of the coal mining areas are in South Bihar proper and Chotanagpur.

Existing Installations

With the exception of Tatanagar and Jharia Collieries there are no other generating stations with modern high pressure steam turbo-generators in the province. Tata Iron & Steel Co.'s Power Station is by far the largest in the province, comprising of two steam power stations of 11700 kW and 25000 kW respectively. The annual demand is 150,000,000 units. The combined output of the

collieries is only about 4000 kW. Individual towns are served by small Diesel Oil Engine plants and consequently uneconomical for large scale production and not practicable for supplying a grid or network. Besides, the oil engine stations do not use the basic product of the province, viz., coal. It is thus seen that the expansion of Diesel engine plants is detrimental to the interests of the province.

North Bihar is mostly agricultural. South Bihar is also agricultural but has a number of industries depending on agricultural products such as sugar mills, oil and rice mills. Part of Chotanagpur, especially along the Damodar valley, is mostly industrial with a large number of collieries, iron and steel industries, potteries, line kilns and other similar industries.

Proposed Scheme

After reviewing the existing generating system, distribution of industries and possible future load conditions, it is possible to draw up a proposed scheme for the whole of the province. A ten year programme can be entered into, in successive stages of 5 years. In the map the completed scheme is shown with major transmission lines only. The province is divided into 4 important zones, viz:—

(1) North Bihar comprising of steam power stations at Motihari, Muzaffarpur and Darbhanga.

(2) Central and South Bihar comprising of steam generating stations, at Arrah, Patna, Monghyr and Bhagalpur.

(3) Industrial area comprising of steam power stations at Gaya, Giridih, Dhanbad with possible additional station in the Barkakhana area, ultimately linking up with the South Chotanagpur scheme.

(4) South Chotanagpur area comprising of Hydro-electric stations at Hundru, Jonha, and Hirni and one or two large steam power stations in the vicinity of Tatanagar.

Power can be generated at 6.6 kV and transmitted on overhead line at 11 kV. The secondary distribution network can be supplied at 6.6 or 3.3 kV pole type outdoor distribution transformers can be used and outdoor substations will be satisfactory.

Approximate Cost of Possible Load

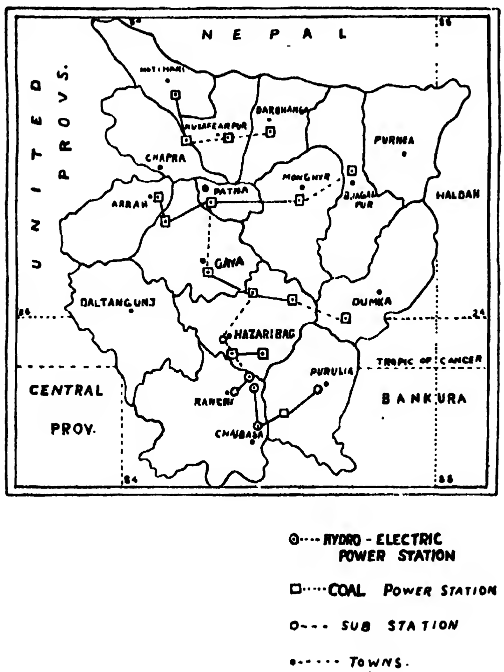
The cost of the entire scheme will be about 10 crores of rupees basing on about Rs. 600/- per kW for Hydro electric and Rs. 220 per kW for steam generation. The first half of the programme with one Hydro electric and 5 steam stations will be in the neighbourhood of 5 crores of rupees. The completed output of the system will be about 80,000 kW including the existing steam plant but this can be limited to about 20,000 kW in the initial programme, excluding of course the generating plants of Tata Iron & Steel Co., Ltd.

To a casual observer it will appear that no load will be available and an extensive scheme will apparently fail, but on closer observation it will be found that in an agricultural country non-industrial load will be available. Thus irrigation and pumping will form a considerable portion of the load. All along the Ganges valley, Son canals, North Bihar, Sahabad and Gaya districts a large amount of energy can be utilized for irrigational purposes. This in turn will produce a better sugarcane crop necessitating greater use of power in sugar mills. The same is applicable to greater part of Chotanagpur which is agricultural. A fair amount of power will be taken by the heavier industries, *i.e.*, coal, iron and steel. Smaller industries like silk weaving, carpet manufacture, saw and oil mills will also be greatly benefited by cheap electricity. Such industries as paper mills can be started when cheap power is available.

Copper is found in Chotanagpur and so is bauxite. Chemical industries, aluminium factories and cement factories will soon be started and give a steady load. In addition to this, some of narrow gauge railways can be electrified and trolley buses or tramways could be started in Patna city.

With the introduction of a scheme of electrification, iron and steel industry and cable factories in the province will be greatly benefited. As a considerable amount of civil engineering work has also to be done, the newly started cement factories will get an incentive. As a large portion of the

amount will be spent in the province this will help to remove the economic depression.



It is thus evident that although the introduction of an extensive electrification scheme will be faced with considerable difficulty, nevertheless in the long run, this will be profitable and consequently this is worth considering.

APPENDIX I

Hundru Falls and Jonha Falls Hydro-electric schemes.

Hundru Falls:—

Static Head 412 ft.
Catchment area—400 sq. miles.
Average annual rainfall—57 inches.
Approximate output ex generators—6000 kW.

Approximate Cost:—		Rs.
Civil engineering works, e.g. dams, pipe lines, power houses	..	30,00,000
Transmission	.. ..	25,00,000
Power Station	.. ..	20,00,000
Sub-station etc.	.. ..	20,00,000
Other expenses	.. ..	15,00,000
		1,20,00,000

Jonha Falls:—

Static head about 175 ft.
Catchment area—300 sq. miles.
Average annual rainfall 57 inches.
Approximate output ex generators—2500 kW.

Approximate Cost:—		Rs.
Civil Engineering	..	30 lakhs.
Transmission	..	5 „
Power station	..	15 „
Sub-station	..	10 „
Other expenses	..	20 „
Total	..	80 lakhs.

Notes and News

Silver Jubilee of the Indian Science Congress

The Silver Jubilee Session of the Indian Science Congress which was a unique event in the history of scientific organization in this country terminated on the 9th January 1937 after full one week's busy programme. It was truly representative of scientific interests in India and was attended by students and scholars of different branches of scientific knowledge from all parts of the country. What makes the session memorable is that it was held jointly with the British Association for the Advancement of Science which had sent out a strong contingent of more than one hundred distinguished scientists, led by Sir James Jeans, who presided over the deliberations of the session. Besides never before in the annals of the Indian Science Congress Association was there such a large number of delegates, nor was the number of papers read and scientific discussions and symposia held ever larger. The different sections too this year numbered the largest.

An important feature of the session, though not directly connected with it, was the arrangement of delivery of popular lectures by distisguished European scientists on various scientific subjects, which included among others those by Sir James Jeans, Sir A. S. Eddington, Dr F. W. Aston, Prof. C. G. Darwin, Prof. H. J. Fleure, Sir Arthur Hill, Prof. C. G. Jung, Dr C. S. Myres, Prof. J. E. Lennard Jones, Dr L. Dudley Stamp. These attracted large gatherings of laymen as well as specialists in the subjects, and were very illuminating. We intend to publish some of these popular addresses in our subsequent issues.

Next Meeting of the Indian Science Congress

The General Committee of the Indian Science Congress Association at a meeting held on Saturday, the 8th January, 1938, decided that the next meeting of the Congress would be held at Lahore from January 2 to 8, 1939. The Committee elected Professor J. C. Ghosh, Head of the Department of Chemistry, University of Dacca, General President of the session.

The following have been elected president for the different sections of the Lahore Session of the Science Congress:—

Section	President
1. Mathematics and Physics	Dr K. R. Ramnatham, Meteorologist, Weather Office, Poona.
2. Chemistry	Dr P. B. Sarkar, Lecturer in Chemistry, Science College, University of Calcutta.
3. Geology	Prof. S. K. Roy, Professor of Geology, Indian School of Mines, Dhanbad.
4. Botany	Dr K. D. Bagchee, Mycologist, Forest Research Institute, Debra Dun.
5. Zoology	Prof. C. R. Naryan Rao, Professor of Zoology, Central College, Bangalore.
6. Anthropology	Dr D. N. Majumdar, Lucnow University.
7. Agriculture	Dr T. V. Ramkrishna Ayyar, Retired Government Entomologist, Madras.
8. Medical Research	Prof. T. S. Tirumutri, Professor of Pathology, Medical College, Madras.
9. Physiology	Prof. N. M. Basu, Professor of Physiology, Presidency College, Calcutta.
10. Psychology	H. P. Maiti, Lecturer, Calcutta University.

The Committee re-appointed Mr W. D. West as General Secretary of the Indian Science Congress Association for the next year.

NOTES AND NEWS

Fish and Himalayan Geography

Knowledge of the great Himalayan Range is so limited that several problems connected with its geology and geography are still in dispute. From researches already made, it seems to be fairly certain that this mighty chain of mountains is considerably younger than the Aravallis and the Vindhyas; in fact it is now generally believed to be the result of at least three major mountain-building movements, all of which occurred during the post-Eocene period some six million years ago. The present-day dominant class of bony fishes had by then already appeared. If the fish have not changed their habits, it can safely be assumed that the directions of water courses have always determined the distribution of fish over large areas. For instance, if a species of fish is found in such widely distributed places as Assam, Bengal, Bihar, the United Provinces, the Punjab and Sind, it can reasonably be conduded that the drainage of these areas must have had chances of intermingling at some period since that species came into being; unless of course the fish were introduced through human agency—a contingency which, geologically speaking became possible only comparatively recently, that is to say, about one million years ago.

Relying on these simple facts and taking into consideration the present-day distribution of the various kinds of Himalayan fish Dr S. L. Hora of the Zoological Survey of India in two articles in the *Records* of the Indian Museum, September 1937, throws fresh light on certain geographical problems connected with the history of the Himalayas.

In the first of his two articles, after a critical examination of the fish fauna of the Northern and Southern sides of the Himalayas, the conclusion is reached that these fauna are totally distinct from each other, though both are believed to have migrated, presumably at different periods, from one ancestral stock in Southern China. These findings have a direct bearing on the history of some of the Indian rivers which have their sources in the trans-Himalayan area. Regarding their past history, two opposing views are held to-day by geologists and geographers. According to one view, the Himalayas, at an early age, had its rivers flowing north and south from the crest. This simple drainage pattern is considered to have been modified to its present form by some of the south-flowing rivers cutting back through range and "capturing" rivers on the Tibetan side. The much greater precipitousness on the southern side of the range, and a much steeper fall, and therefore greater erosive power, are put forward as possible reasons for the unusual behaviour of the south-flowing rivers. Authorities holding the other view believe that the rivers are older than the mountains, and that they kept open their original channels through erosion as the mountains gradually arose to their present heights. The distinctness of the northern and southern fish fauna of the Himalayas, according to Dr Hora, definitely favours the former view. If the rise of the Himalayas had been so slow as to enable the rivers to keep open their channels by vigorous erosion, there would have been little or no difference, as there now is, in the fish fauna of the cis-Himalayan and trans-Himalayan portions of such rivers as the Brahmaputra, the Sutlej, and the Indus. As a general rule, the Himalayan chain, says Dr Hora, was lifted up throughout its range in a more or less uniform manner; but there were some localized upheavals also. From the distribution of fish, Dr Hora traces two such big movements, one in the region between the Assam and Nepal Himalayas, the origin of the highest peaks, and the other in the region of the Potwar Plateau in the Punjab. These movements greatly influenced the normal westward migration of fish along the Himalayas, and divided the mountain range into its three hydro-graphical divisions of the present day: the Brahmaputra and its tributaries, the Ganges and its tributaries, and the Indus and its tributaries. There is abundant evidence, both geological and biological, says Dr Hora, to show that before the occurrence of the above-mentioned localized upheavals, the three rivers were continuous, and drained towards the west, into the Arabian Sea. The presence in all these rivers of larger carp such as *Rohu*, *Catla* and *Mrigal*, and of large cat fish such as *Pangash* and *Silond*, is clear proof in favour of these upheavals. It may be mentioned here that in 1919, two officers of the Geological Survey of India, Sir E. Pascoe and Dr G. E. Pilgrim, independently put forward for the first time this hypothesis, and named the united river the "Siwalik" or the "Indobrahm" River. Dr Hora by his studies not only supports their views but also throws further light on the eastern section of this river.

NOTES AND NEWS

Progress of Agriculture in India

In an illuminating broadcast lecture from Delhi station Sir Bryce Burt, Vice-Chairman of the Imperial Council of Agricultural Research, summarized the progress made in agriculture in this country during the last forty years and gave interesting figures of the number of research and experimental centres.

"There are now in India 22 agricultural institutes and laboratories concerned with the improvement of crop production, about 300 experimental and demonstration farms, a teaching and research staff of 800 officers and assistants and nearly 2,000 officials engaged in the introduction of the successful results of research into general agricultural practice. Improvements in crop production can be brought about in various ways of which the most obvious are introduction of new crops; production and use of good seeds, and in particular better varieties, of existing crops; better feeding of the crop involving the greater and more skilled use of fertilizers and better management of the land; protection of the crop against pests and diseases."

"There are now 83 plant breeding stations in India, and work is in progress on 30 major crops. There have been great developments of this type of research during the last few years and, fortunately, the results can be easily translated into agricultural practice. It is known that improved varieties of crops now occupy some 25 million acres, but this figure quite inadequately represents the total effect on the agriculture of the country for it is known that, in many areas, the agricultural departments' varieties are the dominant components of the crops of the countryside." It has been no easy matter to bridge the gap between the experiment station and the farmer and a brief reference may be made to the machinery employed. Whilst every useful method has been tried and used, most reliance is placed on ocular demonstrations on cultivators' own lands, and no less than 86,000 of these were carried out in 1935-36.

"In addition, there were 150 Government and demonstration farms of various kinds. The demonstrations are organized and controlled by graduates, and others, taught in the agricultural colleges and schools. The actual demonstrators are mainly men of the local cultivating classes who have been specially trained for the purpose. Propaganda has been followed up by 'service' and the agricultural departments have had to perform most of the seed merchant's duties. Last year the numerous Government seed depots issued 12 lakhs of maunds of improved seeds, 150 lakhs of sugarcanes for planting and 6 lakhs of fruit trees. On a smaller scale similar services were performed in regard to the supply of implement and fertilizers. In spreading a knowledge of recommended agricultural improvements most of the known methods of propaganda have been utilized. Fifteen hundred agricultural shows were held last year in various parts of India. Free use has been made of vernacular pamphlets, articles in the press, village lantern lectures, and special short courses both at agricultural colleges and schools and at Government farms. Gramophone records, motor demonstration vans and, last not least, the All-India Radio have all been utilized to bring help and enlightenment to the rural population. It is obvious that both the cultivator and his cattle need to be better fed and, to this end, work is being developed on the improvement of grazing lands, of fodder crops, the introduction of mixed farming and the greater production of those food-crops which are specially needed to correct dietetic deficiencies. These problems are not simple, but several practical avenues of advance are opening up."

Living Index Figures

With the object of obtaining the data for a revision of the official cost of living index figures and collecting information which would be of special value in the consideration of the current problems relating to diet and nutrition, the Ministry for Labour in England inquired last autumn into the working class family expenditure. The response, the Ministry states, has been highly satisfactory. Over 13,600 households have forwarded their "budgets," giving a detailed analysis of their expenditure in one week of October or November last. As prices and expenditure vary in different periods of the year, it would be necessary to supplement the information already obtained by [illegible] relating to [illegible] of the year. The inquiry forms ask for particulars of the composition of the house-hold, rent and rates of the house or dwelling together with the number of rooms occupied, the number of rooms let, if any, and the rent received, the quantity and the cost of each item of food bought throughout the week, expenditure

on gas and electricity during the week, on coal, coke, clothing, furnishing, utensil fares, amusements and any other items and various other particulars.

Philosophy---What should it be?

In his address before the Allahabad University Philosophical Association on January 17, 1938, Lord Samuel, President of the British Institute of Philosophy, who has come to India in connexion of the Silver Jubilee of the Indian Science Congress, pleaded for the need for a new start in our philosophical ideas. There was confusion, he said, in the world today, because nations did not get enough philosophy to rule their ideas, religion,art, politics, etc. It was essential that there should be some philosophy which would guide the nations. He thought that philosophy should be easily understood in order to have a general influence. An ordinary man had to learn philosophy, and so he chose to do without it. Further, if philosophy was to be alive and influential, it must deal with the world of to day and not of old. We must avoid the danger of classicism. We must make a fresh start, form ideas for ourselves and shape a philosophy suited to the modern world after studying what had already been said.

Explaining the relation between philosophy, science and religion, Lord Samuel said that philosophy must take the established conclusions of science as its basis. Mere speculation without scientific proof was of no value. It was useless to proclaim and not to prove, as Professor Radhakrishan has said. Philosophy was a matter of intellect, of rational judgment. When one came to the realm of intuition or mysticism he was in the domain of religion. Doctrines, *Maya* and *Karma* were outside the sphere of philosophy. They belonged to religion. Philosophy, science and religion had each their individual province. Conflicts of religions could be solved by an appeal to philosophy because philosophy stood apart from all religions; the philosopher could go to different creeds one by one and ask them to emphasize the common points and not differences.

One truth could not contradict another truth, said Abdul Baha, of Palestine. This was an important doctrine. Truth must be true everywhere. It was a dangerous doctrine to say that diversities in religion did not matter. Religions must not say things that were in conflict with the established views of Science as the miracle of the Aaron's Rod being turned into a snake. Religious creeds must modify themselves so as to conform with the latest discoveries of science.

On the other hand science must become much less materialistic as it had already become. Philosophy must help in bringing about this reform. Philosophy should help in bringing various religions together. In this connexion he mentioned the work that is being done by the World Fellowship of Faiths. We must emphasize their points of agreement rather than the points of difference.

Continuing Lord Samuel said what the world needed to day was, above all, a synthesis of philosophy, science and religion. This did not mean that they should be one as each had its own province. It was the business of philosophy to bring about this synthesis.

Visit of Sir A. S. Eddington to Allahabad

Sir Arthur S. Eddington F.R.S., the famous astronomer and astrophysicist paid a visit to Allahabad on Dec. 26, on his way to Calcutta from Delhi. In his honour, an astrophysical conference was held at the Physics Lecture Theatre, and this was attended by the leading Indian workers who have done scientific work in lines in which Eddington is interested. Prof. A. C. Banerjee, Head of the Department of Mathematics, welcomed Prof. Eddington in a speech which we reproduce elsewhere.
Papers were read by

Sir S. M. Sulaiman, Prof. N. R. Sen, Prof. V. V. Narliker, Mrs. R. C. Majumdar, Dr R. C. Majumdar, Mr. R. N. Srivastava and Prof. M. N. Saha's paper on the Problems of the Solar Corona was taken as read due to want of time.

After each paper, Sir Arthur Eddington indicated his view-point on the subject of that paper. Sir Shah Sulaiman appealed to Sir Arthur Eddington to persuade some of the great experimentalists to perform experiments in respect of the problem of gravitation with the help of the solar lights.

In the course of his concluding presidential remarks, Sir Arthur said that the time was much too short to discuss the scientific subjects. What has

been interesting him lately, he said, was the connection between relativity and quantum theories and the value of fundamental constants in nature. Relativity dealt with macro physics while quantum theory dealt with micro-physics.

After explaining further the theories in question, Sir Arthur Eddington expressed his feeling of delight at his being able to visit Allahabad, where, he remarked, he had great scientific ties in Prof. Saha, who has done very original work in astro-physics.

The meeting terminated with a vote of thanks to Sir Arthur proposed by Prof. M. N. Saha who, due to want of time, did not speak on his paper.

In thanking Sir Arthur for accepting his invitation to visit Allahabad and to preside over the meeting, Dr. Saha pointed out the difficulties of the scientists in India in carrying on researches in astro physics. In the first place they were all scattered. There was hardly any astro-physical laboratory in India. Dr. Saha hoped that steps would be taken in future to have a suitable astro-physical laboratory.

Civic Reception by Allahabad

Sir Arthur Eddington was accorded a civic reception by the municipal board of Allahabad on the same day. An address in a beautiful silver casket was presented to him by the board. It welcomed the eminent scientist 'in this ancient city of Prayag.' In course of the address it was pointed out that amongst the professors of the Allahabad University there were persons of whom any institution in the world would be proud. But this city badly lacked an astronomical observatory. They had every hope that persons interested in the advancement of science would lose no time in providing the University with such an observatory, a crying need which did not require further emphasis from them.

Sir Arthur Eddington, replying to the address, expressed great delight at the civic welcome accorded to him and thanked the municipal board of Allahabad for it. He paid tributes to the important contributions made by Indian scientists. It was hoped, he said, that the visit of British scientists would be of benefit to Indian scientists, but certainly it would be of benefit to themselves. They belonged to many sections, but everyone of them had some colleague among Indian scientists with whom he had close ties. Indian scientists had done a great deal in the most modern progress of astronomy both by their individual work and by inspiration to others. Allahabad with his colleague, Prof. Saha, was one of the greatest centres of mathematical astronomy and he could only endorse the words of the municipal chairman as to the great benefit of an observatory either here or at any suitable place in India where they had the men to take advantage of it, because it was the man power in an observatory that was of importance. Allahabad was associated with the developments of astro-physics, where Prof. Saha and his puplis were working on lines similar to his own. He hoped Allahabad realized what great work Prof. Saha had done for astro physics when he published his famous paper in 1921.

Sir Arthur Eddington once again thanked the municipal board for its extremely kind welcome and said that in future years he would think of Allahabad with special feelings of affection.

International Congress of Psychology

The Eleventh International Congress of Psychology was held in Paris during the last week of July under the presidency of Prof. H. Piéron of Collège de France. Prof. Pierre Janet kindly consented to be its Honorary President. The opening ceremony took place in the famous Grand Amphithéâtre of Sorbonne in presence of M. Delbos, Minister for foreign affairs, amidst nearly 550 members hailing from all over the world. Official delegates were sent by France, Germany, Italy, America, England, Japan, Hungary, Norway and Poland. The Calcutta Psychological Society was represented by Mr R. N. Ghosh. "From Movement to Conduct" was the central theme on which no less than five symposia were held and in which many eminent psychologists took part. Of the papers read before the Congress the following deserve special mention. 'The outline of the nature of clumsiness' by Prof. Pear; 'Social Conduct' by Prof. Janet; 'Speech Theory' by Prof. Bühler; 'The law of Effect' by Prof. Koffka; and 'The Elucidation of the animal behaviour and the human conduct' by Prof. Katz. Besides these, Prof. Adrián, the well known physiologist of Cambridge, delivered a general lecture on 'the psychological interpretation of the Electrical manifestations of cerebral activities.'

Science in Industry

Crop Research in India

The Advisory Board of the Imperial Council of Agricultural Research, which will meet from March 7 to 12, is expected to draw up a scientific plan of agricultural research. The Governing Body has already laid down the general lines of approach to the research problems in this country, and the conclusion has been the urgent need for carrying the results of research to the cultivators. The question of setting up a special committee which will go into this aspect of the matter is now engaging the attention of the authorities, who it is understood, are in communication with the Provincial Governments in order to ascertain whether Ministers or their Parliamentary Secretaries or their Directors of Agriculture would prefer to sit on the special committee.

As regards the improvement of agricultural livestock, the provinces are at present spending an aggregate of Rs 2 crores, most of which goes to district organizations. But the Governing Body has decided that the Council also should do what it can in this respect. Efforts are being made to examine the whole question, and it is felt that one of the most useful contributions that could be made is something in the nature of a survey of the methods of propaganda in different parts of India.

It is also proposed to collect information as to the ways in which agricultural organizations in India are giving demonstrations to cultivators in improved methods of cultivation, so that when any new method is found to be of advantage to a particular area it can be tried out in other areas under analogous conditions. A mass of materials are being collected on methods that have already come to the notice of authorities, and these will be placed before the meetings of the Advisory Board in March. One of the methods suggested is to demonstrate to villagers the results of agricultural research by means of cinema films which invariably appeal to people in rural areas. The recommendations of the Advisory Board will be reviewed at a special meeting of the Governing Body in June at Simla.

Activities of the Marketing Board

A brief study of the results hitherto achieved by the central marketing staff shows that they have already established 15 experimental grading and marking stations dealing with eight or nine different commodities for example, eggs, tobacco, oranges and grapes. More than 32 lakhs of eggs, 6,000 hides, about two hundred thousand pounds of different kinds of fruits and 75,000 pounds of tobacco have been graded and marked according to the rules. Even allowing for the discarded defective produce but without making allowance on saving in freight in respect of transport of such produce graded products in the case of fruits have shown 6 to 15 per cent., better total return compared with the ungraded ones and in the case of eggs about 10 per cent. co-operative egg grading association established in the North West Frontier Province has made a net profit of Rs. 4,000 - in the course of eight and half months and at the end of the period of experiment has purchased an egg grading machine costing about Rs. 900 - and has also taken over the grading staff with a view to running the station as an independent concern. Examination has shown the ample scope for reduction in the price margin between the producer and the consumer and this offers a most promising line of development with the object of securing better prices for the producer. The producer of wheat and rice for instance gets about 60 per cent. of the price paid by the consumer while in the case of eggs the producer gets one seventh to two-thirds of a consumer's rupee. As regards 'ghee' the question is complicated by adulteration, but the producer apparently gets about 60 or 70 per cent. of the final price. The position as regards fruits is worse. The grower of Nasik grapes gets less than half the price paid by the consumer in Bombay while a producer of Kashmir apples gets about 20 per cent. of the consumer's prices. The difference between the producers, and consumers, prices represents the total cost of distribu

tion including wastage and the charges for freight, packing etc. and steps are being intensively studied in order to minimise these factors.

Oil from Grape Stones

According to the Berlin correspondent of *The Times*, the latest achievement of German chemists is production of oil from grape stones. According to experts attached to the Rhineland wine industry, it will become a commercial possibility within a year. It is estimated that 40,000 litres of oil can be derived from the stones alone. There is nothing, it is claimed, to prevent the production of a million litres of fine graded grape-stone oil every year.

Timber Research

The Government of India, it is understood, have sanctioned the deputation of Mr. S. Kamesam, timber developement and wood preservation officer, Forest Research Institute, Dehra Dun, as the forestry expert of the proposed Travancore University for a period of three years.

Mr. Kamesam's main work will be to carry out scientific investigation into the forest resources of Travancore and the possibilities of the replacement of iron and steel by Travancore timber for engineering, building construction and other allied objects.

It is pointed out that such a replacement of iron and steel by timber has been made by Japan, Scandinavia and other countries and it has resulted in great economy with no diminution in efficiency or safety.

Search for Sources of Eugenol

At the instigation of Netherlands and other European chemical interests, the competent services of the Netherland Indies Government are now conducting experiments to determine whether the Netherlands Indies may become a dependable source of reasonably priced vegetable raw materials or extracts containing eugenol, an essential in the manufacture of vanilin. Fields of search include cloves, cinnamon-leaf oil, and pimentos.

—*The Chemical Age.*

Higher Fatty Alcohols

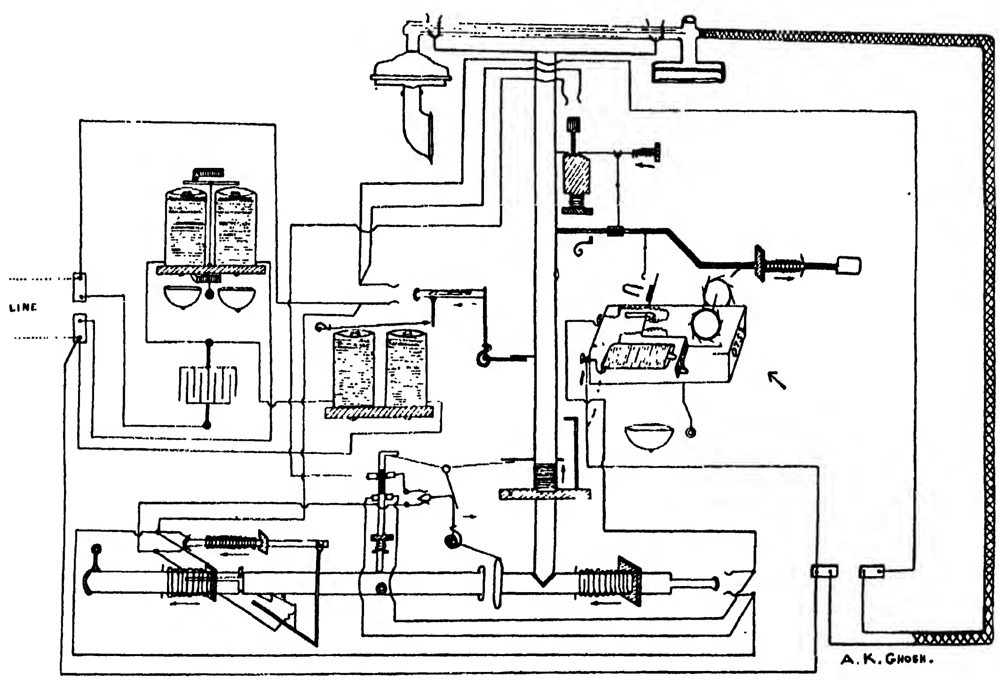
Higher fatty alcohols have been prepared in good yield by the sodium ethyl alcohol reduction of esters by Mitchovitch and Stefanovitsch (*Compt. rend.* 1937, *206*, 386). Equally good yields were obtained when starting from ethyl esters (*e.g.*, ethyl oleate) and glycerides (olein, palmitin, etc.). The method could also be applied to the reduction of olive oil and other natural glycerides. According to the investigators a yield of 60 to 90 per cent. is possible when observing the following precautions: Complete freedom from water of the ethyl alcohol and the glyceride, complete solution of the fatty substance, vigorous stirring, rapid introduction of the sodium, and maintenance of the ethyl alcohol at the boiling point throughout the operation.

—*The Chemical Age.*

New Subscriber's Telephone Set Counts Number of Calls as Well

Ajoy Kumar Ghosh

The wide use of telephone as a means of communication has necessitated the invention of various devices of recording the number of effective calls. Though the general public has to pay according to the number of effective calls registered in the subscriber's metre at the exchange, they have no means of checking the correctness of the statement in this connexion given by the telephone company. Calls are registered by operators in the case of manual exchange system, while in the auto-exchange, they are recorded automatically. It must be admitted that there could be errors in the former system although in the latter errors are not possible. To do away with this and further to satisfy the natural desire of definitely knowing what one pays for and to get an estimate of the number of calls any time during the month a new substation telephone set incorporating the call-registering device has been developed.



This new telephone set has two additional push buttons projecting outside and one 4-digit counting meter visible through a glass window. A simple instrument has to be installed at the exchange to supply series of impulses compounded with tone signals signifying ineffective calls like 'engaged,' 'no reply,' etc. The principle is that if the 'finder' cannot establish connection with the called number or if after the establishment of connection the ringing current passes to the called line or the called line receiver is not lifted more than a certain period, the impulse will pass, say at intervals of three seconds, to the calling line.

When after removing the receiver a button is pressed, the meter advances by one and only then a call can be originated. Mechanism makes only a single such advancement possible for one call as well as only a single call in one advancement. During ineffective calls, which were also recorded, the other button is pressed; the same meter sets back or retracts by one, by the impulse available only during ineffective calls. Only one retraction after one advancement is possible. It has been found that generally over 80% of calls become effective and it necessitates pressing of one button for them; in 20% cases the subscriber smoothly gets his own refund by the second knob. Nothing more than lifting the receiver and replacing it when finished, is required during receiving calls. The meter is therefore beyond the control of either party so as to manipulate it to the disadvantage of the opposite side. Another advantage of the new set is that by a key the set can be rendered inactive to origination of calls leaving it fit to receive calls.

There can be two types of such call registering telephone sets, one for manual exchange system and the other for automatic exchange system. The latter type is more simple so far as inside mechanism is concerned. In the former type a separate loop has been put which is automatically controlled by a relay during the passage of ringing current to the instrument and thus the circuit for incoming calls has been separated from the circuit for outgoing calls which later must pass through the meter. Further a flashing device is provided to draw the attention of the operator independently of cradle movement.

The new set is so dependable that by its introduction it is possible to eliminate call recording equipment installed at the exchange and there can be no cause of misunderstanding and suspicion and further in the manual system the operators will be relieved from attending to the metering job.

Utilization of Tomato-Seed Oil

Experiments in the use of tomato seed oil as a substitute for linseed oil are being carried out in Italy. The oil obtained is semi-siccative and is giving very satisfactory results for paint. The mixture being used is one of 30 per cent tomato seed oil, with 70 per cent linseed oil. The economy of the system is ensured by the enormous quantity of tomato seeds available from the canning industry. The grain when pressed fresh gives about 28 to 29 per cent of oil with 7·5 per cent of water. When the dried seeds are pressed they give 26·3 per cent oil, 30·35 per cent protein, and 5·5 per cent ash. The oil has a composition of 45 per cent olein, 34·2 per cent linolein, 12·47 per cent palmitin, 5·89 per cent stearin and 2·14 per cent of unsaponifiables.

— *The Chemical Age.*

Research Notes

Dielectric Constant of Ionized Gases

During recent years a large number of investigations have been carried out to measure the dielectric constant of an ionized medium in order to test the validity of the Eccles-Larmor theory which demands that the dielectric constant of an ionized gas should be less than unity decreasing proportionately with the increase of ionic concentration.

The experiments with ionized gases were first performed by Barton and Kilby (*Phil. Mag* *26*, 567, 1913) who failed to detect any change in the dielectric constant whereas van der Pol's investigation (Thesis, Utrecht, 1920) showed that the value of the dielectric constant of an ionized gas was greater than unity and that only in the case of very small ionic concentration, the value of the dielectric constant was less than unity. Gutton and Clement (*Comp. Rend.* *184*, 441, 1927) and Gutton (*Ann. de Physique* *13*, 62, 1930) also observed that for ultra high frequences the values of the dielectric constant of an ionized gas was less than unity for small ionizations. Using wavelengths ranging between 58 m and 242 m, Szekely (*Ann. de Physique* *5*, *3*, 112, 1929) found that the dielectric constant of ionized air was greater than one for all ionic concentrations. Appleton and West observed that the dielectric constant of ionized air in a discharge tube was slightly less than one for extremely small pressures and for small tube currents. Appleton and Childs (*Phil. Mag.* (7), *10*, p. 969, 1930) also observed similar features. In their experiments the plates of the experimental condenser were inside the discharge tube. With external condenser plates Appleton and Chapman (*Proc. Phys. Soc.* *44*, 246, 1932) found that the dielectric constant of ionized air which was less than one decreased steadily with the increase of the tube current. Khastgir and Imam (*Phil. Mag.* May, 1937) found the same thing with chlorine and thalium discharge tubes following a different method. Placing the discharge tube between the two Lecher wires, Mitra and Banerjee (*Nature*, *136*, 512, 1935) determined the value of the dielectric constant of ionized air for various frequencies in the ultra high range. The dielectric constant was found to be less than one and it varied directly as $1/f^2$ up to a certain value of the frequency whence the dielectric constant increased as $1/f^2$ increased. The anomalous increase of dielectric constant was also observed later by Khastgir and Imam using a thalium tube and following their methods (*loc. cit.*) The unmistakable turning point in the dielectric constant $1/f^2$ curve was also observed in about the same region when experiments were performed with an electronic medium as found in a high-vacuum thermionic valve (Khastgir and Imam, *Ind. Jour. Physics* *11*, Part 1).

Experimenting with pure electronic medium, Benham (*Phil. Mag.* (7) 11, 457, 1931) and Bergmann and Düring (*Ann. de Phys.* (5) *1*, 1041 1929) showed that the dielectric constant of the medium was less than unity. Repeating Bergmann and Düring's work, Sil (*Phil. Mag.* *16*, 1114, 1933) observed that the value of the dielectric constant was sometimes less, sometimes greater and sometimes equal to unity. Prasad and Verma's experimental results with an electronic medium in a screen grid valve (*Zeits. f. Physik*, *99*, 7/8, 1936) showed some agreement with Eccles-Larmor theory for longer wavelengths (81m to 520m). It was pointed out by Sil and Khastgir and Imam that the anomalous variation of the dielectric constant of an electronic atmosphere in a high-vacuum valve could be explained in view of certain characteristics associated with thermionic valves.

Generally there have been three explanations given of the value of the dielectric constant of an ionized gas greater than one:—(1) Formation of ionic sheaths on the condenser plates when they are placed inside the discharge tube. (Appleton's idea) (2) Existence of quasi elastically bound

electrons (Gutton's idea), and (3) Effect of conductivity acquired by the ionized medium (idea of Pederson, Appleton, Mitra etc.).

That the sheath-effect is real has been shown by Appleton and Childs. Khastgir and Gangopadhyaya (to be published) have shown that the sheath effect is to be found even when the condenser plates are outside the discharge tube the formation of ionic sheath being on the inside surface of the discharge tube. Sheath formation had little or no effect in Mitra and Banerjee's experiments. The Gutton effect has been examined by Appleton and Chapman (*loc. cit.*) and shown to be a distinct phenomenon not connected with the anomaly. The conductivity effect has been demonstrated by Banerjee (*Phil. Mag. 17*, April 1934) and Mitra holds that the anomalous rise of the dielectric constant of ionized air as observed in their experiments on the variation of K with $1/f^2$ can be explained as due to the conductivity acquired by the gas. Further experimental results are awaited with interest.

S. R. Khastgir.

Dietary Prevention of Fatty Livers

Triethyl β-hydroxyethylammonium hydroxide was previously reported to have choline like action in preventing fat deposition in the livers of rats receiving diets high in fats and low in choline and protein. Its action was about 70% of that of choline. Channon, Platt and Smith (*Biochem. J.*, *31*, 1736, 1937) record the results of experiments with two further choline analogues, *viz.*, Tripropyl β hydroxyethylammonium hydroxide (Tripropyl-choline) and trimethyl-γ-hydroxy propyl ammonium hydroxide (homocholine). Groups of rats, each of 10 animals or more were placed on diets producing either the "cholesterol" or "fat" fatty liver. Simultaneously one of the derivatives or choline itself was administered to other groups receiving the same diet. Molecular equivalent quantities of the compounds were incorporated in the diets.

Homocholine has been found to be more effective than choline in controlling the percentage of fat in the livers of rats receiving diets which cause either the "fat" or "cholesterol" fatty liver. The tripropyl-choline was found to be physiologically inactive in contrast with the previous findings in respect of triethylcholine.

H. N. B.

Isolation of Ascorbic Acid from Urine

Indeed there is no complete proof that ascorbic acid is normally present in urine, though indirect evidence obtained by analysis of urine from normal and scorbutic subjects suggests that it is. Attempts at biological identification have failed due to toxicity of urine itself. Drumm, Scarborough and Stewart (*Biochem. J.*, *31*, 1874, 1937) therefore give details of their attempt towards the actual isolation of a derivative of ascorbic acid from normal urine.

Freshly passed normal urine was mixed with sufficient A. R. oxalic acid to produce a concentration of 1% of the acid. 12 litres of the acidified urine were evaporated at atmospheric pressure in CO_2 to 2 litres. The dark brown concentrate was kept overnight, filtered from the ppt, and clarified by norite. The excess of oxalic acid was removed as Ca oxalate and the dehydro-ascorbic acid reduced by H_2S. The excess of H_2S was removed by CO_2. An estimation of ascorbic acid at this point by the usual methods showed that no loss of ascorbic acid occurred by the above process. The urine concentrate was acidified with HCl to $2.5N$ strength and the ascorbic acid oxidised to dehydro-ascorbic by adding a slight excess of N-Iodine solution. 2:4 Dinitrophenylhydrazine solution in hot $2.5N$ HCl was then added and the mixture incubated at 40° for 4 days. The precipitated phenyl hydrazone of dehydroascorbic acid was filtered, washed, dissolved, and finally purified after repeated adsorption on aluminium oxide, crystallisation from acetic acid from acetone or acetone-alcohol. Its identity was established by its crystalline form, m. p. and mixed m. p. with synthetic acid of authentic specimen.

A second hydrazone, similarly adsorbed, has been isolated, but not yet identified.

H. N. B.

RESEARCH NOTES

Internuclear Distance of the Alkali Halide Molecules

The information as regards the very important datum of a molecule, its inter nuclear separation, is best obtained from an analysis either of the purely rotational bands appearing in the infra-red or from that of the vibrational rotational bands. It thus becomes a problem when a molecule refuses to develop bands connecting its state of rotation. Molecules which are typically ionic are found not to give rise to band through which any information regarding their rotational state can be derived, and hence any information as regards their inter nuclear separation is sought from other directions. The other well-known method for this inter-nuclear separation is by a study of the crystal structure and there exists a large amount of data for this quantity from a study of crystalline properties of alkali halides. But the inter-nuclear separation as obtained from a study of the crystalline state may not be the same as obtained when the molecule exists in its purely molecular form unpurturbed by forces of any kind, crystalline or otherwise. Thus L. R. Maxwell, S. B. Hendricks, and V. M. Mosely use the electron diffraction method (*Phys. Rev.*, *52*, 968 1937) to measure the inter-nuclear distance of alkali halide molecules when they exist in a purely molecular state.

A very significant observation about these results is that they are found to be definitely less (about 10% for the halides of Na, K, Rb) than the corresponding known distances in their crystal lattice. In the case of Cs halides the distances obtained by electron diffraction method are as large as 14% less than the separation found in crystals. A table comparing the inter nuclear distances between the crystal and the gas is reproduced below from the above paper:

	Gas.	Lattice.	% reduction in going from crystal to the gas.
NaCl	2.51 (A)	2.814 (A)	10.8
Br	2.64	2.981	11.4
I	2.90	3.231	10.2
KCl	2.79	3.139	11.1
Br	2.94	3.293	10.7
I	3.23	3.526	8.4
RbCl	2.89	3.27	11.6
Br	2.06	3.427	10.7
I	3.26	3.663	11.0
CsCl	3.06	3.560	14.0
Br	3.14	3.713	15.4
I	3.11	3.950	13.6

The data on the nuclear separation given above for gas are expected to prove very useful in testing theories of ionic lattices, since any successful theory should provide also a satisfactory explanation of the nuclear distance in gas.

S. C. Deb.

Oil Refinery hydrogen Sulphide found to be economical Sulphuric Acid Source

F. L. Craise and E. S. Brown. *Chem.* and *Met. Eng.* *44*, 376-9 (July 1937). Converting an industrial waste product ,into a highly profitable by-product was an opportunity which presented itself to the El Segundo refinery of the Standard Oil Company of California. This plant uses in its cracking plant a crude oil running from 0·5 to 2·5 per cent sulphur. The gases from the cracking plant run four to six per cent hydrogen sulphide by volume. Suitable equipment has been designed for removing, purifying, transporting, measuring, and analysing this hydrogen sulphide as well as converting it later into sulphuric acid.

Jour. Chem. Age.

Letters to the Editor

A Note on Dr. S. Dutt's paper on
"Beri-Beri and Mustard Oil."

Considerable interest has recently been focussed on the etiology of epidemic dropsy (popularly known as 'Beri-Beri') through the researches of Lal and Roy[1] who have traced the cause of the trouble to the ingestion of an unknown poisonous substance, conveyed through the agency of mustard oil. This announcement has naturally drawn the attention of numerous investigators to an examination of the various chemical constituents of pure and adulterated mustard oil.

Allylisothiocyanate, being chiefly responsible for the pungent smell of mustard oil, has been most incriminated. Lal and Roy[2] have recently adduced evidence to show that this constituent is not concerned in the production of symptoms resembling epidemic dropsy. The hydrogen cyanide content of mustard oil is so small that attention was not previously drawn to the possible role which this constituent might play in the production of epidemic dropsy. The finding in certain consignments of mustard oil of a fairly large amount of hydrogen cyanide by Dr Dutt[3] and the suggestion put forward regarding the association of this constituent with epidemic dropsy are therefore of very great importance and deserve more than a passing notice. It will be of interest to examine closely the data presented by Dr Dutt and to see whether the conclusions reached by him are tenable in the light of modern knowledge about cyanide poisoning.

(1) It has been stated[3] in page 256 and page 257 (second column) that the symptoms commonly associated with epidemic dropsy are similar to those produced by "cardiac poisons like thevetine, digitoxin, strophanthin, hydrocyanic acid and the cyanides." Physiologists, pharmacologists and clinicians will find it hard to agree with such a statement. Though the etiology of epidemic dropsy has not yet been finally worked out, sufficient work[4,5,6,1] has been reported on the clinical, radiological and pathological aspects of the disease, and the evidence available is conclusive enough to warrant the statement that the circulatory manifestations in epidemic dropsy are typical and characteristic and do not agree with the symptoms produced by drugs of the digitalis group. Hydrogen cyanide has been unfortunately classed in the same category as the digitalis group of drugs. HCN is really a poison to cellular respiration and interferes with cellular oxidations and the circulatory symptoms associated with cyanide poisoning are really secondary to asphyxia of the tissues. Digitalis-like drugs are all characterized by an increase of tone, excitability, contractibility and the refractory phase of the cardiac muscle, with slowing of conduction through the auriculo-ventricular bundle. Such manifestations are seldom, if at all, met with in cyanide poisoning.

(2) The maximum concentration of HCN recorded by Dr Dutt in a consignment of oil from Benares is 0.7 per cent., which is equivalent to 7 mg. of HCN per c.c. of mustard oil. As is generally known, HCN is one of the most powerful poisons and the fatal dose is also very small. The fatal dose has been recorded by different workers[7,8,9,10] as varying from 34 mgms. to 50 mgms. for an adult weighing 70 kilograms. Toxic manifestations will be produced by even smaller amounts. A powerfully toxic or fatal dose of HCN would therefore be obtainable from 5 to 7 c.c. of adulterated mustard oil, a quantity which is not infrequently consumed by a large section of the Bengali population. So far no evidence has been available which indicates that any of the epidemic dropsy cases ever suffered from attacks resembling acute cyanide poisoning by taking adulterated mustard oil. Apparently HCN in such high concentrations is not introduced into the system.

(3) Mustard oil is seldom taken in an uncooked state. Most of it is usually consumed along with curries and fried vegetables. HCN is very volatile and when it is subjected to cooking at a temperature in the neighbourhood of 100 C, it is natural to expect that quite a large amount of it, if not the whole of it, will be volatilized. Dr Dutt admits that the small quantity of HCN ordinarily obtained from all brands of mustard oil (2 parts in 10,000) will be completely volatilized in the process of cooking. It is difficult to see why under identical conditions, a larger quantity of the same volatile substance will not escape during the process of cooking which sometimes takes more than 15 to 30 minutes. At any rate, if a considerable proportion of HCN is volatilized, the remaining portion, will not be in a concentration sufficiently high to produce any undesirable symptoms.

(4) With regard to t statement, "Perhaps the constant intake of such oil ., with high HCN content) might produce slow cyanide poisoning," it may be pointed out that HCN is seldom known to produce chronic poisoning. Though chronic cyanide poisoning has been described in the older literature[11,12,13,14] recent workers[15,16] have failed to substantiate these findings. On the contrary, it has been stated that the body develops tolerance for HCN. The human body i endowed with biochemical defense mechanism which can detoxify a number of chemical poisons. If HCN is administered at a rate which is slower than the normal capacity f detoxification of the system[16] (1 mg. per kilogram per hour in rabbits and 0.5 mg. per kg. per hour in dogs), many times the ordinary fatal dose of HCN could be tolerated. The HCN introduced is almost immediately converted into a comparatively non toxic compound of the type of HSCN[18,19,20] or HCNO[21] through the mediation of the sulphur compounds of the body like cystine, cyste glutathione, etc. Whether it is a purely oxidative conversion or a process in which enzymatic reaction (Rhodanase[22]) enters is still an open question. The reactions which take place may be represented as follows:

$$\begin{matrix} R.-S \\ | \\ R.-S \\ \textit{(Cystine)} \end{matrix} + HCN = R.SH + R.SCN \qquad CH_2.CH.\begin{matrix} -COOH \\ \\ -NH_2 \end{matrix}$$

$$\begin{matrix} R.-S \\ | \\ R.-S \\ \textit{(Cystine)} \end{matrix} + KCN + H_2O = 2\,R.SH + KCNO.$$

It will therefore be appreciated that slow cyanide poisoning is not possible on theoretical grounds. HCN either brings about an acute toxicity or is completely detoxified in the system. Ingestion of sublethal doses of

LETTERS TO THE EDITOR

HCN for even a long period is therefore not likely to lead to slow cyanide poisoning.

These considerations indicate that the suggestion put forward by Dr Dutt with regard to the causation of epidemic dropsy through the constant ingestion of large quantities of hydrogen cyanide, which is obtainable in certain brands of mustard oil, is little far-fetched and is not based on the modern conceptions regarding the physiological reactions of HCN on the system. Unless more conclusive biological evidence is available the suggestion cannot be developed into a theory.

Biochemical Standardization Laboratory, B. Mukerji.
All India Institute of Hygiene and Public Health,
Calcutta.
25-12-37.

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Studies on Ligno-Cellulose

The present work deals with the nature of Lignin. In this investigation the behaviour of lignins obtained from different sources under identical reaction conditions was studied. The sources of the lignins were (1) *Excoecaria agallocha* (vernacular Gongwa) saw dust, (2) dried water hyacinth and (3) rice straw. First of all they were dusted to 20 mesh sieve and for the extraction of lignin, 72% sulphuric acid was used in each case. The lignins were washed repeatedly with hot water till they were completely free from acid, and dried at 100°C and from the filtrates acetic acid was estimated. The lignins were ignited in platinum crucible to red heat by adding alcohol till carbon-free ash was obtained and the difference in weight of the crucible gave the weight of the ash. It is quite evident from the table that ash contents of Gongwa and water hyacinth lignins differ slightly whereas the ash content of straw lignin is very high. Pure cellulose was also obtained from the same sources by the chlorine peroxide process. The lignins were exhaustively methylated and acetylated by dimethyl sulphate and acetic anhydride respectively and the methoxyl and acetyl groups present before and after the exhaustive methylation and acetylation were estimated by the usual processes. It is obvious from the table that the methoxyl and acetyl groups of the lignins from different sources are not the same. The lignins were also chlorinated and nitrated by chlorine gas and 5 N-Nitric acid respectively. The chlorine contents were determined and the soluble and insoluble residues left after nitration were examined. The nitrogen content of the solid residues was determined by combustion and the soluble residues were shaken with ether. The ethereal and aqueous layers showed on examination the presence of anisic acid and oxalic acid respectively. The vapours obtained by heating lignins with 12% HCl did not react with phloroglucinol, showing the absence of pentoses in lignins. The carbon and hydrogen contents were also determined by combustion.

The results, as shown in the following table, indicate that under the same reaction conditions the lignins from different sources do not behave identically.

% on the weight of dried substances.

	Gongwa	Rice straw	Water hyacinth
Lignins	31.2	24.2	15.7
Acetic acid	4.9	9.9	10.3
Pure cellulose	56.0	11.6	42.0

% on the weight of acid free lignin.

	Gongwa	Rice straw	Water hyacinth
Ash	1.92	2.6	1.6
Methoxyl Group:			
Before methylation	14.2	4.15	2.6
After methylation	26.2	11.9	11.2
Acetyl Group:			
Before acetylation	1.3	2.2	2.6
After acetylation	25.2	35.6	31.9
Chlorine (after chlorination)	17.3	16.1	29.2
Nitrogen:			
In solid residue	6.7	3.9	11.1
Ethereal layer	Anisic acid	Anisic acid	Anisic acid
Aqueous layer	Oxalic ,,	Oxalic ,,	Oxalic ,,
Carbon	53.8	42.11	29.0
Hydrogen	5.13	3.25	4.18

The piece of work was carried out in the Department of Applied Chemistry, University College of Science, Calcutta.

Ranchi.
7-1-38

P. N. Sengupta
H. K. Sen.

Manufacture of Pharmaceuticals in India

I was very glad to read in the December issue of 'Science and Culture,' the first instalment of the article on

LETTERS TO THE EDITOR

"The future and prospects of Drug Industry in India" by Messrs J. C. Gupta and B. Mukerjee. Unfortunately I find from the article that the authors are quite unaware of certain facts regarding the manufacture of alkaloids, etc., going on in India. The manufacture of Strychnine has been going on in the very heart of Calcutta for a large number of years in the factory of Messrs Smith Stanistreet & Co. Ltd., 18, Convent Road, Entally. According to the information obtained from the Manager as well as from the impression formed by me in going through their factory every year during the last five years, it would not be far from truth if I say that about 50% of the world consumption of Strychnine is being manufactured in Calcutta. Of course, there is a problem about the disposal of the by-product Brucine which has to be sold at a very cheap rate. Regarding Caffeine, I am informed that it was manufactured for some time by Messrs Smith Stanistreet Co. Ltd., but they had to give it up due to the reluctance of the Tea Association to supply them tea dust even at the same price as paid by the American importers. Some morphine is also being manufactured at the Government Opium Factory, Ghazipur, but of course, there is a big field for undertaking the preparation of various salts of morphine by Indian concerns. As regards Santonine, it is being manufactured at Baramula (Kashmir) for the last few years. In the year 1929, I tried to get Artemesia from Kashmir but I was informed by the Director of the Forest Research Institute, Dehradun, that it could not be supplied to U. P. from Kashmir and that a certain British firm had taken the monopoly of the same.

By the above, I do not mean that there is no future for the Drug Industry in India or that we should not undertake the manufacture of alkaloids, or other substances not so far manufactured here. On the contrary I feel that we should try to manufacture all those products of which the raw materials are available in India. What I deprecate is the tendency among Indian manufacturers simply to copy the products made next door by their competitors without at all thinking of taking up new lines of activity. No firm thinks of experimenting on the manufacture of synthetic camphor, vitamins, hormones, etc., but a pharmaceutical manufacturing concern does not hesitate to take up the manufacture of printing inks, boot polishes, etc., though these products may have nothing to do with the Drug Industry and which are being manufactured by other industrial concerns. Manufacture of a large number of synthetic organic drugs could be undertaken but unfortunately nobody thinks on those lines. My visit to the various manufacturing concerns often makes me despair when I find that the same thing is being repeated and copied everywhere and sometimes wrongly, leading to price-cutting and marketing of understandard drugs. One person who had originality and love for research on new lines is unhappily no more with us, I mean the late Mr. H. Cooper, who in the midst of his numerous administrative duties, was always seen carrying on researches on the utilisation of Indian resources. I wish the manufacturing concerns in Calcutta show some originality in the pharmaceutical field and take up products not at all manufactured in India instead of dissipating their energy in doing things which may do good to nobody.

Department of Pharmaceutics,
Benares Hindu University, M. L. Schroff.
13-1-38.

Metallic Complexes with Oxalenediamidoxime

Oxalenediamidoxime[1], $(NH_2)_2 C_2 (NOH)_2$, has been found to combine with Ni^{++}, Cu^{++}, Hg^{++}, etc., to form coloured inner metallic complexes of the type MeB_2, where $B = C_2H_5N_4O_2$. The nickel compound is completely insoluble in water under certain conditions, and gravimetric estimations up to ·01g. Ni have been successfully carried out. The estimation of mercury is in progress.

The effect of substitution of the amino group by (NH_2CONH) is under investigation, and details of results will be published elsewhere.

St. Joseph's College, Ramgopal Chatterjee.
Darjeeling.
21-12-1937.

1. Ber., 22, 1931 (1889).

Errata

In Vol. 3, No. 7, p. 383, Col. 2, l. 18, *read* pyran *for* fyran
" " " " " " " l. 19, " furan " firan

SCIENCE AND CULTURE

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Poison Gases in Modern Warfare

THE Great War of 1914-1918 was responsible for the development of a technique in attack and defence through the use of chemicals which were not explosives. Early in 1915 it was apparent that the war of attrition had begun. The battlefront in the west expanded from the Swiss mountains to the sea; the British fleet were effectively preventing the entry of essential raw materials into Germany. In their desperate attempts to break through this cordon in land and sea, the German High Command determined to adopt measures of extreme ruthlessness. Indiscriminate submarine attack in sea and extensive use of poison gases on land were the outcome of this policy.

Never was the critical factor of surprise in war nearer success than when the Germans launched their first gas attack at Ypres on 22nd April 1915. Field Marshal Sir John French described the situation as follows:—

"Following a heavy bombardment, the enemy used poison gases for the first time. Aircraft reported that thick yellow smoke had been seen issuing from the enemy trenches. What follows almost defies description. The effect of these poison gases was so virulent as to render the whole of the line held by the division incapable of any action at all. It was at first impossible to realize what had actually happened. The smoke and fumes hid everything from sight and thousands of men were thrown into a comatose and dying condition and within an hour the whole had to be abandoned together with about 50 guns."

Competent critics are of opinion that if the Germans had completely grasped the probability of such colossal success and pressed the advantage with rigour, the channel ports might have fallen and the fate of the war might have been otherwise.

In May 1915, the Germans made similar gas attacks upon the Russians immediately west of Warsaw and with equally deadly results. "The gas was discharged for a total time of not more than half an hour on a front of about 6 miles. The affair seems relatively small, yet what was the result? The Russians lost not less than 5000 dead in the field and their total casualties were 25000 officers and men." No other weapon could have produced results under the most favourable conditions for its use in as many days what gas was able to do in as many minutes.

Poison gases having proved their deadly efficiency, their employment on a large scale was decided upon by all the combatants. In the early attacks the gas under compression was discharged from cylinders into the no man's land in front of the trenches by means of lead pipes, and was transported into enemy lines by favourable winds. The advantage of being able to command the locality of the incidence of gas cloud was immediately realized, and gas shell came into vogue. The poison gases can generally be compressed into the liquid state; and into the shell were charged

these liquids, which, by the use of a small amount of high explosive in the shell, were converted into fine mist when the shell burst. Since gases can diffuse into a wide area, the gas shells need not be fired from guns with the same accuracy of aim as high explosive shells. Guns of simpler mechanical design can therefore be used for this purpose. General Ludendorff tells us that during the big German attacks of 1918, gas shells were used against artillery and infantry in quantities which had never been seen before, and even in open warfare, the troops were asking for gas. It is surmised that about 50% of the shells fired in the last phase of the war were gas shells.

The combination of poison gas with aircraft presents the possibility of attaining strategic effects of immense value by chemical means. The actual hostilities need no longer be confined to the battlefront alone, and the extensive use of poison gas bombs against civilian population has now become common practice. Italy won the war in Abyssinia chiefly with the aid of this weapon. Harrowing tales of air-attack now reach us frequently from the theatres of war in Spain and China. The cruising distance of aeroplanes is rapidly increasing, and destruction of enemy headquarters even at a distance of 2500 miles is not outside the range of probability. Anti-aircraft measures and anti-gas precautions have therefore become imperative in the cities of Western India which are within the striking zone of powerful aircraft operating from hostile bases in Africa.

Poisonous gases may be classified in terms of their physiological action or in terms of their tactical value in military operations. The simplest gaseous poisons have asphyxiating properties. The poisonous action of carbon monoxide, for example, is chiefly upon the blood which is prevented from transporting oxygen, although the lungs are well aerated. Hydrocyanic acid, on the other hand, directly poisons the tissues which are prevented from using oxygen although it might be brought to them in ample amount by the blood. In concentration of 800 parts per million it is rapidly fatal. The French used this gas in large quantities and had very definite evidence of its mortal effect upon German gunners.

The irritant gases produce lesions and congestions in the respiratory system and cause death by suffocation. Chlorine, phosgene, diphosgene, cyanogen chloride, chloropicrin, chlormethyl chlorformate are some of the powerful irritants whose deadly efficiency in war has already been demonstrated. Chlorine and phosgene are fatal at concentrations of 40 parts per million and these were the two gases which inflicted such heavy casualties in the allied armies in 1915.

Another type of gas which has great military value is known as Lachrymators. They produce temporary or permanent blindness by weeping. Typical examples of these poisons are mustard gas, bromacetone, xylybromide and many complex bromine compounds. An account of the first mustard gas attack by a British officer is given below:—

"We were gassed by the mustard stuff on July 22, 1917. The gas was clearly visible and had exactly the same smell as horse radish. It had no immediate effect on the eyes. We suspected a delayed action on the lungs, and I gave orders for all to put on the mouth-pieces and noseclips of their masks so as to breathe none of the stuff. Next morning all of us were absolutely blind. The horrid stuff had a delayed action on the eyes causing temporary blindness about seven hours afterwards. The casualty clearing stations were overcrowded. I however recovered and on the 15th August I was sent to a hospital at home with my eyes still very bloodshot and in an extremely weak condition".

Mustard gas has also another property which revealed the possibilities inherent in chemical warfare. It produced vesicant or skin-burning effects, which, although rarely mortal, were sufficient to put a man out of action for several months. Extensive researches in the direction of preparing more powerful vesicant poisons are in progress all the world over, and the Americans claim to have prepared a liquid called "methyl" which is so powerful that a drop anywhere on the skin would cause death in a few hours.

The chemicals which produce sneezing came into use in the later phases of the war when the mask had become a part of the soldier's normal equipment. Typical substances are some arsenic derivatives—diphenyl chlorarsine, diphenylcyanarsine. These are solid substances enclosed in gas shells and are transformed into ultramicroscopic

dust when the shells burst. This dust was expected to penetrate the protecting materials in the gas mask which are meant for absorbing gases and vapours. Once a speck gets into the nose, violent sneezing accompanied by intense irritation of the nose and throat begins; the protective mask has to be taken off and then the other lethal gases have full play on the victims.

The general protoplasmic poisons, specially the compounds of mercury and lead, are now receiving special attention. Tetraethyl lead is now in common use as an anti-knock compound which is blended with gasolene. Largely diluted with petrol it is almost harmless. But its vapours may be absorbed into the system through the lungs; and acute poisoning takes violent maniacal form–the patient often committing suicide. The great surprise of the next war may be the largescale use of such compounds, which by absorption through the lungs or the skin will derange the nervous system of the combatants and throw entire armies into confusion.

Lastly, we come to the camouflage chemicals. They are extremely malodorous compounds like butylmercaptan, dimethyl thiocarbonate, which are useful to mask the presence of lethal gases. Such compounds have an obvious military value. They enforce the continuous use of the protective mask which is extremely disagreeable to the wearer, or in the alternative, encourage a fatal carelessness in the individual soldier.

From the point of view of military operations the poison gases may be divided into two classes–the persistent types and the non-persistent types. The latter are relatively volatile substances which are useful in attack as it entails little risk to occupy the ground vacated by the enemy a few hours after the gas attack. The highly persistent, highly lethal compounds have introduced a new type of strategic and tactical obstacle. Mustard gas is *par excellence* the war chemical of this type. In the German offensive of March 1918, the Germans protected their flanks by extensive use of mustard gas which practically converted open areas into absolute obstacles against the movement of huge masses of men owing to the certainty of a high percentage of casualties. It is said that for purposes of defence, the German High Command believes more in chemical barrages temporarily put up than in permanent costly fortifications which often become death-traps.

Devices for the protection of the individual against these poisonous chemicals have tried to keep pace with progress in attack. The gas mask is designed to protect the eyes, nose, throat and the skin of the face. The American pattern is shown in the following diagram. The mask proper is made of rubberized fabric and is fitted with eyeglasses and with inlet and outlet tubes fitted with valves. The inlet tube is joined by a rubber tubing

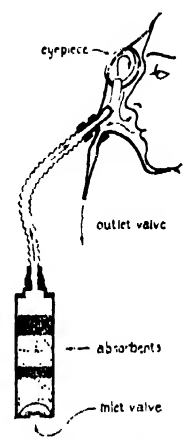

Fig 1– Diagram of gas mask in section

to a canister which contains absorbing materials through which the air must pass during inspiration. The canister is fixed on the chest of the wearer. The chief disadvantage of a mask is its resistance to breathing. This resistance becomes less as the thickness of the absorbing material decreases. Intensive researches are in progress with a view to increasing the efficiency of these absorbents. For protection against sneezing compounds a disc filter prepared by a special method from threads of cotton is fitted on to the canister. The last word has certainly not been spoken in the struggle between the mask and the chemicals attempting to penetrate it. In Table I are given the types of canister for protection under various conditions recommended for use in U. S. A.

POISON GASES IN MODERN WARFARE

It is very difficult to counter the effect of vesicant poisons or poisons which are absorbed into the system through the skin. An oil-skin undergarment and rubberized fabrics for outer garments appear to be the only solution. The physiological effect of such apparel, which absolutely prevents ventilation of the skin, specially in tropical countries like India, has not yet been properly studied. In any case, the mask and this kind of protective clothing must be very disagreeable devices to the wearer and there is no denying that the physical and mental efficiency of the wearer goes down very considerably.

TABLE I.

Conditions	Contents of Canister	Colour of Canister
(1) Protection against organic vapours, such as aniline, gasoline, benzene, ether, toluene, and the like (when not over 20 per cent in air)	600 cubic millilitres or more of activated charcoal.	Black
(2) Protection against acids such as hydrochloric, sulphur dioxide, nitrogen peroxide, chlorine and the like (not over 1 per cent in air).	600 cubic millilitres or more of soda lime or fused caustic soda.	White
(3) Protection against ammonia gas not over 3 per cent. The 3 per cent limit cannot be long endured by the wearer because of the skin irritation from the gas.	Copper sulphate and charcoal.	Green
(4) Protection against carbon monoxide (not over 3 per cent).	A mixture of metallic oxides known as "hopcalite" which catalyzes the combustion of carbon monoxide with oxygen from the air and produces carbon dioxide.	Blue
(5) Protection against all of the above gases ; the "all service mask".	All of the absorbents mentioned above, but only small amounts of each.	Red
(6) Protection against a combination of organic fumes and acid fumes.	Activated charcoal and soda lime.	Yellow
(7) Protection against ammonia and smoke.	Copper sulphate and charcoal with a filter pad for smoke.	Brown
(8) Protection against hydrocyanic acid gas (not over 2 per cent).	Caustic soda impregnated on pads.	with a green stripe

The chemical industries of Germany, England and America have equipment and assets which may be valued at a thousand million pounds. They are, in times of peace, engaged in manufacturing acids, alkalis, fertilizers, dyes, drugs, etc. But, at a moment's notice, their activities can be switched on to the production of war chemicals. If an ounce of a chemical having great military value has once been prepared in a research laboratory, it can be produced in tons in these factories in a fortnight's time. In Great Britain alone, it is estimated that two million pounds are spent every year for researches on these war chemicals and for the perfection of devices for protection against these poisons. Experience has shown that a nation which is industrially backward has practically no means of self-defence in a modern war. War-work of this type is being carried out with such secrecy that it is difficult to forecast the surprises that are in store even for industrially advanced nations when the big powers go to war next time.

The Future of Statistical Work

R. A. Fisher

Galton Professor of Eugenics, University College, London.

In the original sense of the word 'Statistics' was the science of Statecraft; to the political arithmetician of the eighteenth century, its function was to be the eyes and ears of the central government. It could tell the Prince how many able-bodied men he might mobilize, how many would be needed for the essentials of civil life; how numerous or how wealthy, were sectarian minorities who might resent some contemplated change in the laws of property, or of marriage; what was the taxable capacity of a province, his own, or his neighbours.

This aspect of statistical information seems to have been long neglected in England, and we should have to look as far as Italy for a centralized statistical service capable of ensuring that Il Duce is the best informed potentate in Europe. It is certain that the power which such knowledge gives, like the power of lethal weapons, may be abused. On the other hand, it *is* in the public interest that statesmen responsible for political decisions should be able, so clearly as is possible, to foresee the consequences of their public actions.

In democratic countries the emphasis has long fallen upon the important task of providing public information. This function of official statistics is of value both for the aid it gives to private enterprise to use its initiative wisely, and for allowing public opinion an opportunity, at least, of acquiring such a knowledge of quantitative facts as will enable it to pursue aims which are not only worthy, or desirable, but are also within the bounds of practical possibility. It enables public opinion, *if it will*, to size up its problems. The Socratic dictum "know thyself" is applicable even more to peoples than to individuals.

Statistical work is also largely employed as a means to internal efficiency in each great department of Government. I need not stress this aspect of official statistics, which is not, I believe, commonly neglected; save to point out that here also the official service requires a supply of men, who, if they are to be competent, should have at least some specialized statistical training.

More recently, the great centres of scientific research have discovered that statistical science has a vital part to play in all quantitative problems. I will later give some account of this development, which has revolutionized the technical methods of statistics, and has greatly extended the public functions it can fulfil. Heads of research institutions in all countries are feeling the advantage of having as right-hand men statisticians technically capable of drawing up a research programme or of applying to a projected research a rational and objective criticism.

I have formed an opinion, which, be it right or wrong, I should like you to bear in mind throughout this address, that statistics in England has suffered severely from the wide separation, due to our long political history, which has grown up between official and academic statistics; or, to speak functionally, between the duties of collection, enumeration, tabulation and publication, which absorb the time of official statisticians, and the duty of study, analysis and interpretation, which falls to the lot of the mathematical or theoretical statisticians. A body, such as the Royal Statistical Society, does something to bridge this gap.

How wide the gap may seem may be illustrated by some witty comments made by A. L. Bowley in criticism of the presentation of official data. He was moved to draft an ideal footnote, which might find a place in any government publication. I cannot recall his exact words but the following is an attempt to recapture the spirit of his criticism.

Footnote:—(*a*) The terms used in the headings and margins of the table are all employed in a technical sense, known only to officers who compiled it, and which they are unable for official reasons to divulge.

(*b*) The sub-divisions of the table and the region to which it refers have been changed since the last return was published.

(*c*) Before tabulation the data have been subjected to numerous adjustments, allowances and other corrections, of a kind to vitiate any tests of significance which the reader may be tempted to apply to them.

The academic mind, as we know, is sometimes capable of assuming an aggressive attitude. The official mind, on the contrary, is and has to be, expert in the art of self-defence. If half of Bowley's indictment is true, it will always be easy, when analytic methods are rashly applied to official material, to show how frequently the material falsifies the assumptions made in the course of analysis; to sneer at the elaboration of the calculation employed, or at the refinements which have been introduced, always without emphasizing the obvious fact that the more imperfectly the work of compilation has been done the more elaborate and difficult must be the task of extracting objective information. My point here is that in developing her statistical services India might learn from the difficulties which England had encountered, and somehow contrive neither to allow official statisticians to be blinded by ignorance of method, nor to allow academic statisticians to be sterilized by lack of responsible experience.

So recently as twenty years ago the task of the statistician, faced with an accumulated mass of observational data was understood to consist in the calculations of certain average values; by that time also it had become usual to employ the quantities of the second degree, squares and products, to elicit from the data what are known as "probable errors", regarded as appropriate to the average values obtained. In putting the matter in this way I mean a wide interpretation to be given to the term average, for these are of many different kinds and any large body of data will yield an immense variety of them. Which to choose must depend partly on what sort of information it is desired to obtain, and this part is not properly a statistical question. But expert statistical knowledge was recognized to be necessary for a comprehension of the arithmetical processes sufficient to ensure that they were appropriate to the meanings to be placed on them. This narrow measure of responsibility was however enlarged by the fact that all extensive bodies of data are liable to contain information on points which were not in view when they were collected; to recognize such information, and to find the means of eliciting it was most stimulating part of the statisticians' task.

As an illustration I may point to the widespread and important type of data known as time-series; such as are provided by annual figures of births, deaths, exports, prices and the whole range of vital and commercial statistics, the proper treatment of which has been a classical problem to all who are interested in national or sociological questions. Data of the same kind are amassed by meteorologists, and arise when agricultural experimentation is carried out continuously on the same land. In studying such data as this at Rothamsted it was found that a series of averages, using weights determined by position in the sequence, would provide, *first*, the linear trend representing the greater part of soil deterioration, *next*, a few terms representing other slow changes ascribable to changes in variety, cultural practice and intensity of weed infestation, and *finally*, a residuum of more rapid fluctuations dominated by the variation of the weather from season to season. Moreover, the separation effected in this was such as to allow the year-to-year fluctuation to be studied in relation to meteorological causes, just as if the series were not affected at all by the large, slow changes actually present.

The classical theory of errors due to the great German mathematician Gauss had shown how the interpretation of such estimates could be sided by taking account of the whole body of discrepancies. The residue of unexplained variation provides, in fact, the material for the calculation of probable errors, or in more modern usage, of standard errors. In 1908 the late W. S. Gossett, whose untimely death last year still casts a shadow on

our discussions, wrote under the pseudonym of "Student" a paper, little appreciated at the time, which opened the door to a refinement of exactitude of which the theory of errors had hitherto seemed incapable. The concept of standard error is in fact insufficiently exact for application without reserve to the small samples of observations which the experimenter can command. Nevertheless, it was shown possible in an important range of cases to develop rigorously exact tests of significance from which the concept of standard error may be entirely eliminated. That the importance of Student's suggestion was not at once recognized illustrates all too clearly how ignorant academic statisticians were of the important decisions which experimental scientists, like statesmen, must take, always on the basis of a limited knowledge of fact. Biological research, however, throughout the world bristled with problems which only exact tests adapted to a very wide variety of logical situations had come into existence. In a few years more they were in general use among experimentalists. The period which followed has shown the somewhat ludicrous spectacle of entomologists, foresters, plant physiologists, and others with no trace of mathematical pretensions, applying freely and with understanding in their daily work mathematical refinements, which most official statisticians could not understand, and which too many teachers in mathematical departments were unable to expound.

The development of exact test of significance had been based on the mathematical solutions of a number of what are known as *problems of distribution.* The solutions found were not very difficult mathematically. Certainly they were not beyond the power of the great series of mathematicians who, from the time of Laplace, have given their minds to the theory of probability. Had these minds been put into direct contact with the problems which beset the laboratory worker we cannot doubt that they would have been solved by them some sixty years earlier. I want to insist on the important moral that responsibility for the teaching of statistical methods in our universities must be entrusted, certainly to highly trained mathematicians, but only to such mathematicians as have had sufficiently prolonged experience of practical research, and of responsibility for drawing conclusions from actual data, upon which practical action is to be taken. Mathematical acuteness alone is not enough. My revered teacher, Prof. Whitehead of Cambridge, used to say in one of his courses: "The essence of applied mathematics is to know what to ignore." And when I read current publications in mathematical statistics I am continually and forcibly reminded of the wisdom of this remark.

The solution of problems of distribution, although stimulated by the practical needs of chemists and biologists, had at once important mathematical consequences. For, if the statistician asks himself, as he ought, "What is my best method of averaging or combining the data before me," so as to elicit information on some definite issue, it is evident that he must be guided by the magnitude, and the nature of the sampling errors to which different estimates are liable. This, in a few words, is the genesis of the theory of estimation. In this theory we discuss what advantages each of innumerable possible estimates possesses, and what procedure will enable us to combine these advantages in our estimates. I shall hope to develop the theory more fully in a series of lectures at the University of Calcutta next week. For the moment, I want to note only the consequences of the progress so far made in this field as they affect the future of statistical research, and the position and responsibilities of the statistician.

A few years ago no statistician who had completed his work on an extensive mass of data could feel any rational assurance that some other statistician, using the same data, could not by some new method calculate estimates much more precise than his own. In these circumstances it was natural that if his results were actually rather precise he should display them with some satisfaction; if not, he might in his chagrin even suppress them. High correlations and strongly significant comparisons were displayed with considerable pride, for they seemed to indicate not merely that the data were good, but that they had been brilliantly handled. But now, observe the change, so soon as any young graduate who has mastered the theory can lay down the equations for the most efficient estimates possible, the

whole tone of the subject has been altered. The statistician is no longer an alchemist expected to produce gold from any worthless material offered him. He is more like a chemist capable of assaying exactly how much of value it contains, and capable also of extracting this amount, and no more. In these circumstances, it would be foolish to commend a statistician because his results are precise, or to reprove because they are not. If he is competent in his craft, the value of the result follows solely from the value of the material given him. It contains so much information and no more. His job is only to produce what it contains.

The mathematical measurements of quantity of information has another and more fruitful consequence. If we want more than has been found to be present we are no longer tempted to harass the statistician to work miracles. On the contrary, since he can evaluate the material, we may require him to explain what was wrong with the data that more did not come of it. What supplementary information which could also have been collected would have been worth collecting? At what points could the material be most profitably amplified? In what respects also has the labour of collection been unprofitable, so that our resources may be employed in future where the yield is highest? Get the statistician to redesign the enquiry, and to justify his new plan by the methods of costings accountancy. Here the door is opened on work very well worth doing indeed. Immensely laborious calculations on inferior data may increase the yield from 95 to 100 per cent. A gain of 5 per cent of a perhaps small total. A competent overhauling of the process of collection, or of the experimental design, may often increase the yield ten or twelve fold, for the same cost in time and labour. To consult the statistician after an experiment is finished is often merely to ask him to conduct a *post mortem* examination. He can perhaps say what the experiment died of. To utilize this kind of experience he must be induced to use his imagination, and to foresee in advance the difficulties and uncertainties with which, if they are not foreseen, his investigations will be beset.

I have tried to show that India, in the construction of her national organization, has a great opportunity to utilize the newly discovered possibilities of Statistical Science. This Conference is itself the strongest evidence that the will to seize this opportunity is not lacking. When I see too the widespread interest developing in this country in all branches of statistical work, and above all the brilliant school of workers that Prof. Mahalanobis has gathered round him in this University I suggest that we can put every confidence that the work will be carried forward with the intellectual integrity that such a task requires.

* Presidential Address of the First Indian Statistical Conference held at Calcutta on January, 7, 8, and 9, 1938.

Synthetic Perfumes Excel

The synthetic perfumes of modern tencent stores excel those for which perilous sea voyages and hazardous caravans probed the Orient in the Middle Ages, Dr Charles F. H. Allen, of the Eastman Kodak Company, declared at a recent meeting of the American Chemical Society.

America's beauty bill, he added, annually runs to over 200,000,000 dollars, even when a most conservative estimate is taken. Much of this is profit; for, said the scientist, the jar containing the cosmetic may well be the most expensive part. For example: jar, six cents; contents, two cents.

Synthetic perfumes duplicate natural perfumes in everything but cost. Natural oil of rose costs 175 dollars a pound, while the same product, made in the laboratory, costs only $22.50 a pound.

—*Science Service*

The Idea of the Nation in Europe

H. J. Fleure
Professor of Geography, University of Manchester.

FORMERLY it was the custom to make history begin with a long Neolithic period during which, it was supposed, men were learning the arts of cultivation and the settled life, and various attempts were made to locate a European centre where these arts developed. The most foolish of these attempts suggested the Baltic as the primary home of civilization. Were it not for its disastrous political consequences this perversion of science might pass unnoticed, its value scientifically is nil.

We now realize that the Neolithic period was really a short one heralding the advance of metal, and, indeed, we are continually getting hints that finds we call Neolithic are finds of the remains of people who were in direct or indirect contact with metal users but lacked much metal themselves. They were people spreading from hand to hand as much as possible of the arts of cultivation and its accompaniments of polished stone tools, elementry metallurgy, pottery, building in wood, in stone, observation of the heavenly bodies, rites of fertility, ploughing, care of domestic animals, for milk and work and in some areas flesh, and so on. Metallurgy needed more organizing than the other arts and so did not spread as fast. That is why we have a Neolithic period and in many parts of Europe it did not really last 500 years.

When these arts got to the Mediterranean Sea, they found many things to help them. The olive, vine, and fig tree, either native there or brought from some place not very far off, gave a good source of fats and sugars. The myriad bees made honey on the heaths. The island with embayed coasts gave opportunities for fishing and the chains of islands in sight of one another gave opportunities for sea-trade in the small boats of those days which had no compass to guide them, but no doubt found the regularity of the climate a considerable help. These all encouraged settlement in towns on a harbour, especially as so much of the rock is lime-stone, and springs are to be found only at special points near which, naturally, people concentrate. Trees bearing olives and figs grew in the lands around and gave welcome shade in the dry summar heat, and when trade developed supplements of grain could be brought in from regions better suited to its growth. So we have the City as the basic idea in social order in the Mediterranean and yet we notice with interest how long it took to transplant this complicated organism from east to west in that sea. The cities at the east-end are almost two thousand years older than those of the western basin. Some of us suspect that trading monopolists tried to keep the west for themselves and so hindered the spread of the city for a long time; but that is speculation.

What is important is to notice that the Mediterranean lands of Europe, which had developed the idea of the city early, evolved the idea of the nation very late, in fact, imported it from the northwest in the 19th century. Their ideas and ideals, as one can gather from literature, as well as from life, gathered around the city and in many places, even very small ones, the population of perhaps a few hundred cultivators lives in what one cannot but call a miniature city. The real village, as India or Europe, north of the Mediterranean, would understand it, is rare. The rivalry between the cities was the curse of ancient Greece, and Rome strove for a unified control of all the cities around the Mediterranean, not for the creation of a Roman nation as we should understand that word.

When we turn to non-Mediterranean Europe the contrast is a dramatic one. Archaeology tells a story of the gradual advance of villages from east to west through central Europe, choosing

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naturally the lands less thickly covered with forest. The villages were at first apparently rather temporary affairs, lasting for a few years till the people left exhausted patches of soil to clear new ones. Far away from the sea the communications were not good enough to give rise to large groups of traders, such early trade as there was seems to have depended on little stations for travelling groups. In east central Europe there were practically no cities until 1,000 years after cities had grown near the Aegean Sea, and in western Europe the city began to appear only very shortly before the beginning of our era, *i.e.*, some seven centuries after the foundation of Rome. In the long period of village civilization one can of course trace a considerable development. From being temporary the villages became more parmanent and larger, and it is obvious that the people came to have more domestic animals, that they learnt to smelt copper pyrites with tin sand and so to make bronze and that when Bohemia, Iberian Peninsula, Brittany, Cornwall and Ireland were all producing one or other of these important commodities bronze became much commoner and equipment improved. But after an advance there came a setback, the forest trees of Denmark changed, the oak which thrives in rather drier warmer condition gave place to the beech which has delicate leaves suited to wetter cooler summers, peat bogs spread in many places that had previously had forest covering in France, Britain, and Scandinavia, the lake-shore villages of Switzerland were swamped by the increase of the lakes, passes through the mountains that had been used for trade became blocked all the year round by snow. The old civilization that was growing up near the west Baltic declined; the legends tell us of cold, dark winter following one another with no summer in between. It is interesting that this phase of cool damp climate is indicated for most parts of Europe, that it apparently brought a valued increase of rain to the Mediterranean, and to some parts of Arabia, and that even some of the Egyptian bases, such as Kharga, had a fresh start after many centuries of utter barrenness It would be a most valuable line of research to find out whether India also had any change of climate in the remarkable period of her sages.

The setback made the peoples of Europe north of the Alps much more dependent on cattle and much more mobile, so they moved southward, and history tells us of Rome's campaigns to keep them from ravaging the borders of her urban civilization. With all her equipment in thought, in means of communication, in discipline and in iron work Rome did so succeed for a time with the result that the idea of the city was added to that of the village in the west.

In the south of France the vine, fig and olive would all grow, Mediterranean life was possible, cattle and sheep could also be kept in numbers, especially if they were led up to the hills for summer pasture. There was an opportunity to fuse together the urban and the village civilizations with the urban predominant, especially as communications were easy in a low-land without much dense forest and with gravelled river terraces to act as pathways. We thus find southern France deeply Romanized with Roman cities like Nemis, Arles, Toulouse still important to-day, and cherishing the great buildings that they put up in the time of the Roman Empire and still use to-day. The Roman tradition has left a deep mark in their speech which is not quite standard French; it is known as the Langue d' Oc. After the setback that followed the break of Roman organization and the advance of Islam cutting Mediterranean trade routes they showed the power of the Roman tradition by adopting Roman Law as their guide in settlement of disputes, and by other features it would take too long to discuss. With that revival of law in the 12th century of our era they became energetic in building and built as the Roman had done with the round arch and the dome. This is Roman France but both within and on its borders it makes a transition to the other France which must next claim our attention. France, north of its central highlands, could not grow the olive, but it would keep cattle more than the south; so it got its supply of fats mainly in another way. It could grow the vine well only in warm spots on the sunward hill slopes, it was a good wheat land wherever the soil lay over limestone or sandstone, and there was a lot of limestone. So it had become a land of cattle and crops with villages to which the Romans added cities that in many cases began as camps for soldiers. One

can still find main features of a Roman camp in quite a number of French towns, but almost nowhere do we get the great buildings of the Roman times preserved. The Franks who knew little about a city conquered the land, and soon Islam had cut Mediterranean trade. So the Roman cities declined to grow again some centuries later in what we in Europe call the Middle Ages under the leadership of the Roman Church. To these towns came the villagers to markets and fairs; so rural and urban lives were linked together here in the early Middle Ages more than anywhere else in Europe, and this was a linking of the less Roman with the more Roman.

But here, in contrast to what we find in the south, the courts decided by local customs not according to Roman Law, and the people rebuilding churches and cities soon gave up the round arch and invented a special style with pointed arches and other features that we call Gothic.

In spite of these and many other differences there was however enough in common between north and south for them to grow to understand one another and in the end to work together. For more than one thousand years they have had a common measure of thought and feeling in spite of many wars, and that common measure has given a common motive power that has built up the French nation. Yet there is enough diversity between north and south; one might also speak of east and west to give variety within the unity of the French people. They are a case of unity in moderate diversity, everywhere the Roman tradition, still expressing itself in religious forms, everywhere the balance of urban and rural, of Roman and non-Roman, the two together enriching the common life by much more than the sum-total of their respective contributions for their conjuncture has led to the mountain of new things that, as it were, surmount the differences between the two. That is the great advantage of co-operation between diverse peoples, well conducted it leads to freedom of thought and all sorts of initiative. France is an old nation now, well matured, free from the fear that some part of her may want to separate itself, unfortunately full of the fear that a neighbour may attack her; but even that fear is made to prompt unity in action. As an old nation that can allow her people to think for themselves she has a government that can be criticized by the citizens who elect it. France is what we call a Democracy.

Let us try to get a sketch of Germany in the same way. Here, the tie of the land is a very vital fact. In the first place the Rhine, of old, made a considerable barrier before rocks were blasted and navigation developed. It was once a national frontier, and was used as such by the Roman Empire with results that are still clearly apparent in modern life. It has thence been thought by some superficial observers that it might be a frontier again, but this is impossible so long as frontiers mean what they do to-day, and if a reign of good-will replaced the present one of lust of power, there would be no reason for a frontier there. We may therefore briefly consider the Rhine in its relation to German life without bringing in any implication about frontiers at all.

The Romans had frontier camps that grew into a long line of cities from Koln to Basel and, when the Roman Empire fell, these cities had Christian bishops, who kept up the tradition of law and order to some extent so that the bishops' cities mostly survived the disorderly centuries that followed, though they were reduced in population as people had to move out into the country to grow food for themselves. When the revival of trade came after about 500 years, the idea of the city began to spread into the country east of the Rhine where many clearings had been made in the forest by cultivators.

East of the Rhine Germany divides itself broadly into three regions. In the south there are the great basins of Danube, Main and Neckar outlined by the ridges of the Alpine Foreland and some older blocks like the Black Forest. In the centre is what the German scholars call the Mittelschwelle, an old highland block broken by faults and variegated by volcanic lumps making a tangle of deep valleys among the hills. In the north was the German part of the northern European plain marked into longitudinal zones by morainic hills, seamed often crosswise by great rivers the Elbe, the Oder, with the Vistula beyond the truly German area.

The economic development of the northern plain as such was long delayed. Its soils were poor, its climate severe. The Elbe was accepted as a frontier for a while. The southern basins were easier to develop, and we get Swabia, Franconia, Bavaria, and so on, standing out as rival units at various times.

The middle region with its deeply divided valleys became a multitude of small states. There was here no one centre that could gather the country around it as did Paris in France. In fact, the physical geography of this region is one of the main reasons why a German nation did not arise alongside of the French one in the early Middle Ages.

Instead, we find a desire to redevelop a Roman Empire with the Rhine and Danube as its basis; the idea of a unity of German-speaking people had hardly dawned. We also find that the ideal of the city spread from Rhine and Danube eastward and north-eastward into regions where no towns of any consequence existed. Some towns grew around a site occupied by a bishop, some around the castle of a lord, some at fords and other modes of communication where groups of traders gathered under the rather distant protection of the Emperor or a lesser but sometimes more effective lord. A great deal of effort and no little pride and idealism that in England and France expressed itself as patriotism went in Germany into the city, and the German City with its Council House (Rat-haus) has long been one of the great features of European civilization. Its burgher families, an aristrocacy of trade and commerce, usually controlled it even if a bishop or a lord were somewhere near. The cities of the south centre and centre were the greater number but the famous Hanse commercial cities grew on and near the north coast.

These growths of cities beyond the old Roman frontier created centres which had but an indirect and vague connection with the Roman tradition unless any city had been founded by a bishop. At the end of the Middle Ages therefore, when the Old Church broke down, it thence came about that a deep religious rift developed from the south and west of Germany and the northern plain while the hilly centre became patched with both allegiances. This delayed the process of national unification for centuries while that development was going on strongly in France and England. It also led to some gains for German culture. Many minor courts, put out of deplomatic importance by the growth of communications became patrons of music and learning, while philosophers made efforts none too successfully to transcend the religious division.

Meanwhile, however, a new factor appeared. Through welcoming refugees Berlin had become a centre of thought. Canals were built from Oder to Spree and so to the Elbe giving the plain real access to the open sea. Also new crops, such as potatoes and turnips, spread and revolutionized agriculture and population on the northern lowland; so Berlin, a quite small place in 1650, began its immense growth that ultimately, with the advent of railway in the nineteenth century, was to furnish the nucleus around which the national idea could grow.

It grew, with differences that make the German nation contrast very markedly with the French and the English. In the latter two the growth was already well advanced in the days of Joan of Arc and of Elizabeth. The nation was a concept deep in the minds of the rural aristocracy and had spread, from them to the people in England; in France it began in much the same way but gained a new passionate intensity in the revolution of 1789. Commercial and industrial development in the 19th century was therefore a concept very separate from the idea of the nation in France and England; on the other hand, the two ideas, unfolding themselves together among a people with very strong burgher traditions, have been inextricably interwoven in the picture of the nation that the Germans have formed. The burghers keen on their town affairs have often been willing to leave the highest control in the hands of a leader, Kaiser or Führer, who is, as it were, head of a firm, the departments of which must fit into one another to avoid waste. Politics are not the natural occupation of the aristrocacy as they were of old in Britain. It is the businessman's code rather than that of the rural sportsman which sets the tone, and, in international affairs this

means a code practically unchecked by law —Der total Krieg.

Summing up, one may say

(*a*) That a fund of experiences and ideas common to the greater part of the people is a great aid to national unity as it restricts rifts in opinion.

(*b*) If there are deep rifts in opinion the common and cheap way of dealing with them is by methods of suppression, usually costly in the long run as the dissentients who get suppressed and persecuted include some of the ablest of the people as well, of course, as some who favour brute violence. To discriminate between these two dissenting types is generally impossible. Another difficulty of this policy is that it represses science and so makes a community fall back.

(*c*) Deep rifts in opinion may be tolerated in the hope that a common measure may arise in due course, but this is a difficult policy for a nation, and it needs to be supplemented by efforts to transcend the rifts through some new synthesis. What might not India have won ,had Akbar really been able to bring about a religious synthesis!

(*d*) It is therefore better to have organizations of national character on not too large a scale, so that the common measure within the nation of this size and character is exposed to serious danger unless it can link itself permanently with others like it—for example in a confederation, of which the Swiss may be taken as an almost ideal example. Europe is in need of such a federation; its separate nationalisms are a sad hindrance. May India help us by showing us the way to a federation with freedom both for the dissimilar units and for the minorities within each and all of those units.*

Lecture delivered at Calcutta on January 5, 1938

Injury by Drugs and Cosmetics

After reviewing the state of national health during the past year, the annual report of the chief medical officer of the Ministry of Health, Sir Arthur MacNalty, directs attention to some instances where injury has been caused through misuse of chemicals. A warning is given that no slimming drug or preparation should ever be taken except on medical advice and one drug—dinitrophenol—should not be taken in any circumstances. While it is true that dinitrophenol is now covered by the new Poisons Rules and can only be obtained by medical prescription, untoward results have been only too frequent even when every care has been taken. Cosmetic preparations have sometimes been found to be a source of danger. In the case of lipstick, the dye was mostly at fault, and eosin was frequently found to be responsible. It is stated that hair dyes of vegetable origin would seem to be innocuous, but those which depend upon *p*-phenylenediamine or its derivatives might give rise to most severe dermatitis with other developments, and fatalities had been recorded.

—*The Chemical Age.*

Mechanism of Cyclones in the Bay of Bengal

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THE principal air masses[1] over the Indian region may be conveniently classified as follows:

(*a*) *Cold.*—The cold northwesterlies from the Caspian Sea side (the Western Himalayan air) and the cold northeasterlies from Tibet and China (the Eastern Himalayan air*). These are cold continental or "extra-tropical" currents.

(*b*) *Moist.*—The "equatorial" current, or the southeast trades and the southwest monsoon according to season.

(*c*) *Warm.*—Warm and only slightly moist westerly drift or "tropical" air presumably coming from the thermal equator. This is to be distinguished from the hot continental air generated over India itself in the summer months.

The prognosis of the formation and movement of cylones in the Indian seas is still a vexed problem. The horizontal temperature gradients at the surface, associated with the Indian cyclones, are weak in comparison with similar gradients in the case of cyclones of higher latitudes. This difficulty in regard to modern analysis may perhaps be overcome if it is assumed that an Indian cyclone is the outcome of two convergences between three air masses, *viz.*, a convergence aloft between the extra-tropical which brings cold, and the equatorial which brings moisture, and another below between the tropical bringing warmth, and the equatorial. It should be mentioned that the two convergences may pass through various adjustments before the final structure is established.

The movement of discontinuities between any two of the three air masses is generally small from day to day. Taking advantage of this fact, the writer, since 1930, has been drawing a progressive series of convergence patterns at the several levels aloft between the different air trajectories, paying particular attention to the dominant currents and the "simulation" of trajectories in different air masses in juxtaposition, together with the "deformation fields" which arise out of a strong convergence. This method has been successfully applied in daily forecasting and in the analysis of charts for the predictions of the birth of cyclones in the sea areas and also of more localized storms such as nor'westers in Bengal.

In order to avoid complications we shall, unless otherwise stated, confine our attention mainly to the trajectories aloft between 2-3 km. above sea level as shewn in the diagram below.

The two fields A and B, which are the characteristic seasonal fields of large dimensions, may be called the general deformation fields. While drawing the convergence patterns it is helpful to remember the following seasonal peculiarities:

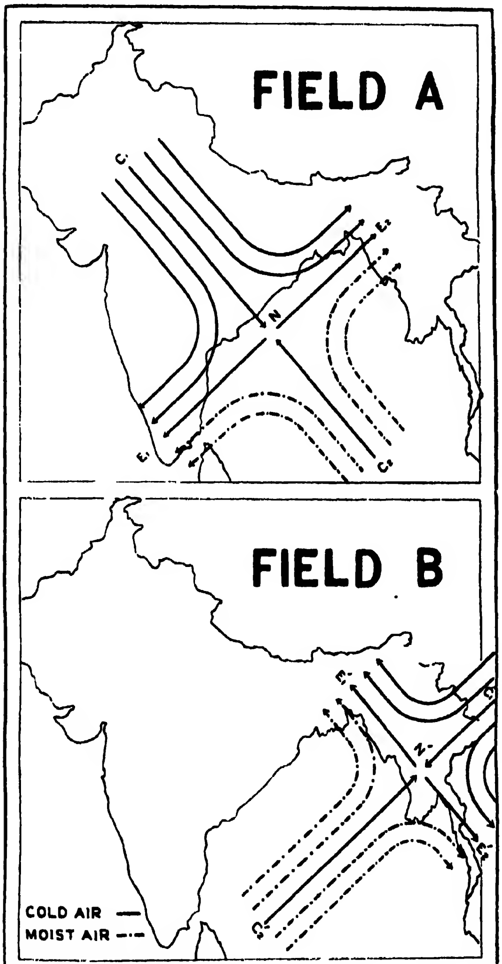
(*a*) During the winter and summer the dominance of the deformation field A arising out of a strong convergence between the western Himalayan current and the southeast trades;

(*b*) the dominance of the field B during the monsoon resulting from a strong convergence between the eastern Himalayan and the southwest monsoon currents;

* This has to be distinguished from the maritime polar air from the Pacific.

(*c*) the co-existence of the fields A and B or their intermittent activity particularly during the transition months;

GENERAL DEFORMATION FIELDS



(*d*) the more or less inert character of a deformation field arising out of a strong convergence between the tropical and extra-tropical currents chiefly over the Arabian Sea in spite of threatening isobaric distribution at the surface.

It may be mentioned that, at least in the case of the field A when well established, the pressure readings for appropriate levels which are daily available from a number of hill stations, fully bring out the characteristic isobaric distribution of an ideal Bjerknes' deformation field. There can be no doubt regarding the seasonal persistency of the axis of extension in varying degrees. As a matter of fact, a consideration of these points and of the urge and reactions, produced by a deformation field growing in height, often associated with characteristic pressure changes in the different sectors or " lobes ", is of great help in daily forecasting in all seasons. In the case of the northeastern half of the field A, the periodic appearance of roll clouds, extending from southeast to northwest and travelling from southwest to northeast, towards Assam, in the summer evenings and nights, is one of the marked seasonal features of Bengal. When the field is active typical afternoon thunderstorms occur almost daily along the axis of extension and the summer regional maxima of rainfall appear in Assam and the south of the Peninsula, approximately the two extremities of the axis. As regards the motion of translation of this axis, it is found from charts of average winds aloft that, during the first transition period, the western Himalayan air is pushed away to northwest India and beyond, from over the Bay, and returns to this area during the second. In this connection the primary and secondary maxima of the frequency of cyclones in the Arabian Sea, as shewn in the following table, are interesting. In August the western Himalayan air is more or less outside the Indian area and cyclonic circulations originating on the Arabian Sea side in this month are rare and restricted to Gujerat and neighbourhood. Those monsoon depressions however, which travel from the Bay of Bengal to Northwest India, often intensify while over Rajputana with the temporary return of this air mass and travel north-eastwards. By the end of August the southeast trades apparently re-enter the Indian area and the tropical current begins taking possession of the south Arabian Sea preparing the southwest monsoon to retreat.

MECHANISM OF CYCLONES IN THE BAY OF BENGAL

In the case of the Bay of Bengal, on the other hand, there is only one peak in the frequency of cyclones and this is reached at the height of the monsoon when the field B is established. This field, however, must remain more or less hypothetical, for the present, owing to lack of upper air observations to the east of Longitude 100°E. It may be pointed out that a marked divergence in the characteristically thick layer of monsoon winds across Burma is often noticeable and, when monsoon depressions are forming, heavy rain-squalls generally set in over the Tenasserim, East Bengal and Assam (*i.e.*, along the axis of extension).

fall of temperature underneath the cold limbs suggests essentially the same mechanism. It is thus clear that fresh supplies of cold air aloft and a convergence between the moist and warm currents below may eventually furnish the deformation field with an axis of extension with a sharp thermal gradient across it and also appropriate humidity conditions.

Another important source of instability contributing towards the formation of cyclones may now be mentioned. A strengthening or partial dissipation of one of the four limbs of the deformation field, when more or less over the sea, usually leads to a loss of equilibrium along the axis of extension originating either to the left or to the right of the neutral point. The loss of swaying

TABLE †

Percentage Frequency of Cyclones and Western Disturbances. Annual Variation. (1891-1935)

Cyclones originating in	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Bay of Bengal ...	1.9	0.0	0.6	2.5	6.1	9.8	14.4	15.7	15.5	14.8	12.5	6.2
Arabian Sea ...	0.0	0.0	1.6	4.7	14.1	31.3	7.8	0.0	6.2	18.7	10.9	4.7
Western Disturbance. ...	15.0	14.1	16.0	13.8	8.3	3.2	1.3	1.0	2.6	5.9	7.0	11.8

When a cyclone is brewing, the seasonal deformation field is found to grow and extend upwards to large heights and acquire increasing persistency. There is evidence to show that these growing deformation fields aloft also characteristically influence the surface circulations, thus directing convergence between tropical and equatorial currents in layers below 2 km. The available records of upper air temperature point to the fact that, on the eve of the formation of a cyclone, the deformation field obtains fresh supplies of extra-tropical air. In the case of the field A these cold waves aloft are often associated with the northeastward passage of western depressions or of disturbances in the Arabian Sea. In the case of the field B the characteristic trend of

balance may be brought about by many factors, such as interaction of two deformation fields, local heating, subsidence of cold air along slopes (including katabatic flow[2]), orography and the accentuation of seasonal low pressure areas etc. For example, in the case of April cyclones the limb E_1NC_1 of the field A is often dissipated when a western disturbance is affecting northwest India and cyclones usually generate in E_2NC_2. This ***diagonal relationship*** between the dissipation of a cold air limb and the formation cyclone in the moist air lobe opposite holds in all months. From this fact, it is reasonable to conclude that

† The basis of this is the same as that of Table I in SCIENCE AND CULTURE, June 1937, p.598.

during the monsoon, the limb $E'_2N'C'_1$ is generally dissipated giving rise to a cyclone in $E_1N'C'_2$ through the loss of swaying balance along E'_1N' and that no marked thermal gradient is, as a rule, to be expected over the Andaman Sea in this season.

A cyclone does not necessarily form near the axis of extension[3] of the main deformation field. As a matter of fact, the thermal gradient arising out of the convergence of the moist and warm air may be some distance away from the axis of extension. In these cases what presumably happens is that, once the swaying balance of the general deformation field is lost in the manner already explained, the penetration‡ of cold air proceeds until a subsidiary deformation field arises in the appropriate moist wind lobe. This in its turn gives rise to a core which eventually grows into a cyclone.

As regards the direction of movement of a cyclone it is to be observed that the motion is along the moist air trajectories. As a matter of fact, once the centre of a depression can be located, the moist air trajectory on top of the cyclone passing over the point, gives the future track when due allowance is made for extraneous causes such as outbursts of the tropical current, etc. These considerations may eventually furnish a basis for the determination of the speed of travel of a cyclone at the various stages.

It may so happen that the field B may produce a depression and hand it over to the field A for future movement and intensification. Even two depressions may simultaneously exist in the Bay of Bengal at the extremities of a trough and eventually coalesce. These phenomena are often associated with a double system of subsidence of cold air over the Bay of Bengal and the subject may be reserved for a future discussion.

The following points should be remembered in connection with the premonitary signs of the formation of a cyclone:—

‡ If instead the moist air penetrates the cold air lobe during the life history of a depression an occlusion occurs.

(*i*) One of the two thunderstorm areas at the ends of the axis of extension, away from the neutral point definitely penetrates into the moist air sector in which the cyclone is to form. This fact along with the characteristic regional changes of temperature and absolute humidity is often useful in overcoming the handicap of large interpolations involved in the drawing of the deformation field over the Bay of Bengal.

(*ii*) In the Indian region localized heavy rain is often regarded as one of the premonitary signs of the formation of cyclones. This criterion, however, should be used with caution in view of the fact that heavy rain may even occur

(*a*) along the axis of extension during the seasonal growth of the deformation field as the plane passing through the axes at the various levels tends to become vertical,

(*b*) along the track of small whirls,

(*c*) when some passing external disturbance induces a temporary penetration of one of the cold air limbs into the adjoining moist wind sector,

(*d*) when external reactions cause merely occlusions or convergences,

(*e*) due to an accentuation of seasonal low pressure areas.

The following factors contribute to the intensification of cyclones: -

(*a*) the augmentation of the cold air supply in the deformation field from external sources,

(*b*) the descent and availability of cold air below the 2 km. level,

(*c*) a decrease in the distance of the centre of a cyclone from the neutral point,

(*d*) an accentuation of the thermal gradient across the axis of extension,

(*e*) the coalescence of two whirls originating at the extremities of a trough.

References

1. *Science and Culture.*, June 1937, p.593.
2. *Nature*, January 1931, p.128.
3. *American M. W. R.*, June 1936, p.199.

The Catalogue of the Coins of Ancient India by Mr John Allan, 1936—a Review

Durga Prasad
Benares.

UNDOUBTEDLY Mr Allan has added another valuable contribution to Indian Numismatics by publishing a profusely illustrated Catalogue of the coins of Ancient India in the British Museum. The book is divided into 5 parts with Indexes, and mainly deals with the three different indigenous systems of ancient Indian coinage, namely, the copper and silver punch-marked coins; the uninscribed cast and die-struck coppers; and the chronologically later inscribed copper and silver coins, which are still available from the known ancient sites like Taxila, Ahichhatra, Kosambi, Madhuri, and Rajgir. Mr Allan has rightly stated the lack of the recorded historical and exact chronological data with which one is faced when studying the innumerable varieties of coins of the ancient Hindu India, up to the beginning of the Christian era. But this should not be counted as an absolutely hopeless task. A careful *search* amongst the ancient Indian archaeological monuments and remains for the symbols engraved upon them, and *resifting* of the ancient Sanskrit Brahmanical and Buddhistic literature, giving allowance for the peculiar ancient custom of describing facts mingled with the so-called myths and exaggerations prevalent amongst almost all the ancient civilized nations millenniums before the Christian era, provide us with clues in which we find a sort of *terra firma* to stand upon, and obtain clear glimpses in the hazy period of ancient Indian history, which enables us to assign, with some amount of certainty, definite places to the ancient Indian coins chronologically.

It is easy to measure the length of a room or a rod accurately with the help of an instrument of precision correct to a small fraction of an inch, but when it is required to measure the inaccessible distance of the Moon we adopt a different method, and feel satisfied if after careful mathematical calculations and measurements we arrive at a result which is correct within a few hundred miles. The same is the case with ancient coins. Definite periods of many punch-marked and uninscribed die-struck, and cast copper coins have been determined and, of many more, could be assigned if carefully studied.

The silver punch-marked coins bearing the symbol of three arched hills  with a crescent, the Tripuri, are definitely Mauryan. (*Vide* Dr K. P. Jayaswal's Mauryan Symbols in *JRAS*, July 1936, *Numismatic Supplement* Vol. XLV, May 1935; and the Jubilee number of the same).

In the illustrations in the Catalogue the silver punch-marked coins are jumbled together on Pls. XLI and XLII, without any arrangement of the wellknown systematic grouping of symbols found on the coins, which go to indicate clearly a connecting series of coins of different known periods, and are helpful in determining their chronological order and age to a considerable extent. The illustrated plates of the punch-marked coins are not at all helpful for studies and comparison; they are quite unlike the plates of the catalogue of the Gupta coins of the British Museum or the Tribal coins illustrated in this very Catalogue.

The description of some of the coins as well as of their symbols is not correct, and some of the latter are inaccurately drawn, and some new figures which do not exist on the coins are illustrated in the list of symbols in the introduction on pages *xxii* to *lxix*.

It would suffice to quote a few such mistakes in the catalogue.

Coin Fig. 4, on Pl. VIII—has a clear bull stand-

ing on a 5-arched hill,  (Fig. 32e Pl. XXXV *Numismatic Supplement* No. XLV). The tops of the upper two arches are seen on the coin, and there is no rhinoceros as illustrated and described on page 63 under the variety " f " of the coins.

Coin Fig. 24, on Pl. VIII—is wrongly classified under variety " f " on page 71, the symbols on the coins are clear, there is the sun symbol with slant rays, the six-pointed " Sadarachakra " of the type 10 illustrated on page *xxiii* of the catalogue; a rhinoceros is also to be seen with its horn on the snout bent backwards and one ear near the neck correctly depicted quite unlike the figure on coin 12 on the same plate; the 4th is a complete figure like No. 10 illustrated on page *xxx*, and a tree not very clear on the coin. I have a similar well-preserved coin in my cabinet, weighing only 44 grains. As the coin is not much worn out, it seems to be a coin of 25 *ratti* standard weight of the type of the sun-symbol coin. It may be a coin of the 5th century B.C. of Magadha: coins of different types of 25 *ratti* standard weight or 45 grains, of the kingdoms of Pāñcāla, Kośala, and Surasenas are known, the first two are in the Lucknow Museum and the 3rd is in my cabinet which I obtained from Mathura fresh from a hoard of 25 coins.

The sun symbol is shown with 14 rays in every symbol-group illustration in the Catalogue, which is inaccurate, for it should be of 16 rays.

I had the occasion of particularly counting the number of rays of this symbol on over 8000 silver punch-marked coins from a dozen hoards now in the Patna, Lucknow, Lahore, Taxila, Peshawar, Bombay, Madras, and Calcutta Museums, and other private collections including mine own. I could notice 16 rays on ninety nine per cent of the coins, and very rarely 14 or 20 rays all drawn radially with a few exceptions of slant rays on the coins of earlier type.

The sun symbol is not always seen completely on the coins, but the number of rays can be easily calculated from the arc of the figure punched on the coins, which is generally found to be 16.

Some of the 6 armed symbols the sadar-chakra, as illustrated in the Catalogue on page *xxiii*, Figs. 3 and 4 are incomplete, the complete figures are illustrated in the *Numismatic Supplement* Vol. XLV, Pl. XVI, Figs 22 and 23.

Figs 1 and 4 on page *xxvi*, are not correctly drawn, no elephant with raised trunk is seen on the silver punch-marked coins, it is seen with its trunk hanging, four legs and tail, depicted with 6 thick lines and a small dot in the head representing an eye, two long curved tusks.

Figs. 3, 4, and 5 on page *xxvii*, are not symbols, thye are seen owing to the superimposition of 2 or 3 symbols and flattening of the figures on the coin by long use.

Fig. 7 on page *xxvii* is the symbol of an elephant with a taurine over it, the coins referred to on Pl. V, No. 8 and 18 clearly show the hanging trunk and the 2 curved tusks flattened and joined together. It is not a taurine. The correct figure copied from a well preserved coin bearing the same symbol group is illustrated on Pl. 26 Fig. 29a of the N. S. Vol. XLV.

Fig. 1 on page *xxvi* -the couchant bull is not correct; it is a standing bull with 2 fishes in a frame, and owing to the small size of the bull its 4 legs are not seen separate, but get mixed. The lines of the frame and hoofs of the legs are seen on the right top corner of the coin No. 4, Pl. VI of the Catalogue. I have never seen a couchant bull on silver punch-marked coins. For the correct figure see *Numismatic Supplement* Vol. XLV, Pl. 26, No. 32e.

Figs. 10 and 11 on page *xxx* are not complete; For the complete figure see *N. S.* Vol. XLV, Pl. 26, No. 53.

Most of the figures of plants and trees are not drawn correctly, to enumerate them would be lengthy, but it may just be said that the figures are drawn as seen by the artist on the coins, but I think if an attempt of classifying the coins bearing the same symbol groups and the allied series were made and illustrated on the same plate in an order, such mistakes would have been eliminated, and the complete figures found out; I wish Mr. Allan were as accurate in the description of punch-marked coins as he was scrupulously correct in his Gupta coins.

It is the symbols on the coins and their grouping by which the silver punch-marked coins can be classified and arranged chronologically. Hence

inaccuracies in drawing the symbols would be misleading.

The single type silver punch marked coins are not struck on the Persian standard.

Dealing with the single type silver punched coins on page *xvi*, Mr. Allan while describing the bent-bar silver punched coins (Salákás) as illustrated on Pl. I, Nos. 1, 2, and 3 says, "The interesting features about these pieces are that they are struck on a Persian standard and represent double sigloi, or staters, half and quarter sigloi. The sigloi does not seem to be known."

Formulating this theory of Persian origin he emphasizes on the point of provenance of these coins in the N. W. Provinces, which was in the neighbourhood of the eastern empire of the Acheminids from the end of the 6th century to the middle of the 4th century B. C.

But this theory that the bent-bars-punch-marked coins were struck after the Persian standard of the weight of a double siglos does not stand the test when we examine the weights of 33 similar coins which were dug out from Birmound at Taxila during the excavations of 1924-25 along with 1059 silver punch marked coins, 2 fresh coins of Alexander, a fresh coin of Philip Aridaeus and a worn Persian siglos of the type of the 4th or 5th century B.C. all found in an earthen pot mixed with some gold ornaments of the Mauryan or Pre Mauryan type. The heaviest one of these 33 coins weighs 179.4 grains, and the average weight of all the 33 coins including the worn ones comes to 175.6 grs. The following are the weights of the so called bent-bar punch-marked coins now in the Taxila Museum:--

	grs.		grs.		grs.
No. 1	172.3	No. 2	174.9	No. 3	173
No. 4	177.2	No. 5	177.5	No. 6	178.1
No. 7	177.4	No. 8	175.1	No. 9	176.9
No. 10	175.3	No. 11	175.1	No. 12	178.36
No. 13	169.5	No. 14	175.5	No. 15	177.4
No. 16	179.4	No. 17	174.6	No. 18	176.4
No. 19	177.9	No. 20	172.3	No. 21	174.0
No. 22	175.3	No. 23	176.0	No. 24	176.9
No. 25	175.3	No. 26	175.0	No. 27	177.6
No. 28	173.0	No. 29	177.0	No. 30	172.3
No. 31	176.2	No. 32	176.6	No. 33	175.9

The maximum weight of a Persian Siglos is said to be 86.45 grains (*Cam. Hist. of India*, Vol. I, 343). double of which would be 172.9 or 173 grs.

The heaviest of the bent bars in the British Museum, No. 2 Pl. I weighs 177.3 grs. and the average weight of the seven coins excluding No. 4 which is very much worn is 174.9 grs.

How could the differences of excess weight of the heaviest coins of Birmound and of the British Museum by 6.5 and 4.4 grains respectively be explained? Even comparing their average weights which are 175.6 and 174.9 grains respectively the bent bars are found to be heavier than the double of a siglos by 2.7 and 2 grains in their worn condition. It may also be noted that only six of the Birmound coins, Nos. 1, 3, 13, 20, 28 and 30 weigh 173 grains or a little less, while the remaining 27 coins weigh 174 grs. and above, of which 10 are heavier than 177 grains.

If they were actually struck after the standard weight of a double siglos the average weight of these coins should be less than 173 grains as the coins are actually somewhat worn; unless it is proved that the actual weight of a siglos was 90 grains, the double of which would be 180 grs; it would be hazardous to say that the so-called bent bars were struck after the Persian standard weight of a double siglos. As far as I know no double siglos has come to light. It appears that these coins belong to Gandhar kingdom and were struck there after the Indian standard of 100 *rattis* which weighed 180 grains. The ancient standard *Ractica* was calculated by Thomas and Cunningham to be of 1.8 grains, I came to the same conclusion after weighing a large number of coins though in the time of the Mauryan emperors it was a little less, about 1.75 grains.

It may be pointed out that the word bent-bar is not a correct nomenclature for these coins, as only half a dozen of the 33 Birmound coins are found bent owing to the punching at the two ends by big punches on the same side, the rest are straight, śalākā would be the proper word, this was also used by Elliot first, to denote long punch-marked coins.

The symbol at the two ends of the coins is not a cross-and-ball figure as described by Sir John Marshall. It is neither a wheel, nor a sun-like

design, it is a clear 6-pointed symbol well known in Sanskrit as Sadarachakra, the points resemble a Trisula and its variations. May it not be the symbol of Saivite cult known from very early times. 

I would like to add here that coins of 25 *rattis* standard weight, the padas ¼ of 100 Ratti Coins of the 6th or 7th century B.C. are known and published. The Paila hoard of over 1100 from Pañchala, the 11 broad of Kośala coins in the Lucknow Museum, and 20 Suraseni coins from Mathura in my cabinet are all of 25 *ratti* standard weight of about 45 grains (Vide *Numismatic Supplement*, Vol. XLV, Pls. I, II, III, VI, and XXXI), and the Jubilee Number of the same Supplement.

Even the copper coins of 100 *rattis* weight of early times are known. In the early kingdom of Magadha at Rajgir copper coins of twenty Másakas of 100 Ractikas, 180 grs., were current, even the higher and fractional denominations were known. Coins illustrated on Pls. XII and XIII of the new Catalogue are the early coins of Rajgir. I had obtained several exactly similar coins from Rajgir, weighing about 100, and 150 *rattis*, there are four or five in the Patna Museum, Captain Martin obtained two at Calcutta from a gentleman who obtained them from Rajgir.* In brief it may be said that coinage on the decimal system was known in India in the early days in copper and silver both, and that the bent-bars the Salákás were struck on the Indian standard of 100 *rattis* 180 grs., and not on the Persian standard; the mere approach in weight of a few worn bent-bars to that of the double of a Persian Siglos is not a criterion of the theory of their Persian origin.

* Cunningham in his *'Coins of Ancient India'* has illustrated 100 *Ratti* Coins of Taxila.

Expanding Work of the Imperial Institute

A most important part of the work of the Imperial Institute is the examination of samples submitted from Empire countries in order that the commercial possibilities of the product in the British market might be determined. The examination is conducted by two departments of the Institute, Mineral Resources and Plant and Animal Products, both in the laboratory and through commercial inquiry. The annual report of the Institute for 1937 records further expansion in the forging of these economic links between the countries of the Empire. The advisory technical committees on minerals have been reorganized and renamed; these now number seven and include consultative committees on precious metals, base metals, coal and petroleum, iron and ferro-alloy metals, and chemical industries. The number of technical inquiries dealt with by the Mineral Resources Department continued to rise during the year, the total of 1,101 representing an increase of nearly 19 per cent. over that of 1936. Laboratory investigations involved the examination of 317 samples from 30 countries.

—*The Chemical Age*

A Survey of Recent Advances in Magnetism Relating to Chemistry

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THE subject of magnetism in relation to chemistry has attracted special interest only during recent years although Faraday, Perkin, Curie, Honda and Owen showed early how it could be usefully employed in solving chemical problems. These developments had to wait, as the theoretical side of magnetism was rather shrouded in mystery. The theoretical advances in magnetism following the lead of Langevin and the great strides in atomic physics and quantum mechanical theories have facilitated the application of this subject to chemistry. Special mention must be made of the contributions of Van Vleck, Stoner, Bloch, Heisenberg, Lewis and Pauling.

The rapidity with which the subject of magnetism in relation to chemistry has grown may be judged from the fact that since the appearance of the first book in English on the subject of magneto-chemistry (MacMillans, 1935), two books one by Honda, and the other by Klemm—have already appeared, and even in the short period which has elapsed since the appearance of these books, there has been an almost encyclopaedical output of work on magneto-chemical problems. In my survey of magneto-chemistry I shall confine myself to the following:—

1. Magnetic moments and nuclear chemistry.
2. Magnetic properties of free atoms and molecules.
3. Magnetic properties of elements.
4. Molecular diamagnetism.
5. Paramagnetism of molecules, free radicals and bi-radicals.
6. Polymerization.
7. Magnetic properties in relation to phase equilibrium.
8. Influence of the magnetic field on homogeneous and heterogeneous equilibria.
9. Catalysis and magnetic properties.
10. Magneto-optical analysis.
11. Photomagnetic effect.

Magnetic Moments and Nuclear Chemistry

With the discovery of the neutron and the position as definite physical entities, Heisenberg's theory of the neutron-proton constitution of the nucleus was put on a firm experimental basis and the older theory of proton-electron constitution of the nucleus had to be rejected. The only serious difficulty which remains to be explained is the emission of β-particles by radio-active elements. To circumvent this difficulty it has been suggested that electrons are formed just before the β-rays are emitted. This has led to the postulation of a neutrino a hypothetical particle with no charge and with a mass equal to or less than that of the electron. It is probable that the neutrino has no magnetic moment.

The nuclei have mechanical spins associated with them. The total nuclear spin gives rise to the nuclear magnetic moment which combines with the magnetic field produced by the electrons and with the orbital moment to give rise to the hyperfine structure. The absence of hyperfine structure therefore indicates the absence of a nuclear magnetic moment. The nuclear magnetic moments are related to the constitution of the nuclei. Experimental determination of their values has of late attracted considerable attention and the following methods have been developed:

1. *Hyperfine structure.—(a) by spectrophotography.* This method is due to Goudsmit and has

been employed to determine the magnetic moments of Sc, Cs, Li, K, Na, Cu-isotopes, Sb-isotopes, etc.

(*b*) *By Polarization of resonance radiation.*—Ellett and Heydenburg have developed a method of determining the hyperfine separations by observing the change in the intensity of the radiation from atoms in the magnetic field. By this method very small hyperfine separations for Cs and Na have been determined.

2. *Deflection of Atomic and Molecular Beams in a nonhomogeneous magnetic field.*—The original method of Stern and Gerlach of passing a beam of neutral particles through a non-homogeneous magnetic field, as modified by Stern, Estermann and Frisch, has been employed in particular for measuring the magnetic moment of the proton by carrying out experiments with para- and ortho-hydrogen. An extremely ingenious modified form of the atomic beam method has been developed by Rabi, and employed in the determination of the nuclear moments of the alkali metal atoms.

3. *Other Methods.*—(*i*) From the velocity of conversion of *p*-hydrogen and deuterium into the *o*-variety Farkas and Farkas have deduced the ratio of their nuclear magnetic moments to be 3.96.

(*ii*) By passing a beam of particles through two sets of magnetized iron bars used as analyser and polarizer respectively, Frisch, Halban and Kosch have developed a method for determining the sign of the magnetic moment of the neutron, which is shown to be negative, as if the particle carried a negative charge (*i.e.*, behaved like an antiproton).

Magnetic Properties of Free Atoms and Molecules

The work done with the help of the atomic beam deflection method on the magnetic moments of atoms is in entire agreement with theoretical predictions based on spectroscopic grounds. Oxygen atoms in an electrodeless discharge yielded a value of 1.67 Bohr magnetons. In the case of Bi, Leu obtained an undeflected beam at a temperature of 1183°K in spite of the ground-state of bismuth being $^4S_{3/2}$. This was attributed to the presence of Bi_2 molecules. A discrepancy in the earlier work on iron was removed, Klabunde and Phipps having shown that the magnetic moment of the iron atom is 2.03 Bohr magnetons and not zero as previously obtained by Gerlach.

The di-atomic molecules of the elements of the sixth group of the Periodic Table (Oxygen, Sulphur, Selenium, Tellurium) have two valency electrons in an incomplete shell and therefore possess a diamagnetic $^1\Sigma$ and a paramagnetic $^3\Sigma_1$ state. As to oxygen and sulphur, it has been established for a long time both by spectroscopic and magnetic evidence, that the di-atomic molecules are para-magnetic, *i.e.*, $^3\Sigma$ is the lower of the two states. There is a chance that in the heavier elements of this group the $^1\Sigma$ level may be the lowest. Spectroscopic investigations have so far not been able to bring about a decision, but magnetic measurements by Bhatnagar, Lessheim and Khanna have shown that Se_2 vapour is paramagnetic and therefore has a $^3\Sigma$ ground-state like O_2 and S_2.

Measurements by various workers on Br, A, Ne, Kr and Xe have established the fact that their susceptibilities are in accord with theoretical values. Iodine in solution was studied in the author's laboratories and was found to ionize in carbon disulphide and benzene, but to remain in the molecular state in cyclohexane.

Magnetic Properties of Elements

Susceptibility of elements en masse.—The magnetic properties of substances in the solid or liquid state differ from those of free molecules in so far as owing to interaction with neighbouring molecules or atoms a structural influence is super-imposed on the molecular magnetism.

In special cases like that of the rare earths it is still possible to draw conclusions regarding magnetic moments from measurements of the solid substance. All of them follow the Curie-Weiss law, except gadolinium and possibly cerium. Gadolinium is ferromagnetic with a Curie temperature of 16°C. the low temperature saturation moment per atom being greater than that of iron. The behaviour of cerium is still under dispute.

Prins and Coffin examined an amorphous form of antimony. Bates and Baqi measured the

magnetic susceptibility of chromium. A good deal of controversy still exists regarding the susceptibility of mercury in the liquid state, which disagrees with that in the vapour state and is probably due to liquid mercury forming polyatomic molecules.

Mention must be made of the work on bismuth, which on account of its abnormal diamagnetism and other anomalous magnetic properties has been a centre of interest both theoretically and experimentally. The bismuth crystal has a layer lattice with homopolar linkages within the layers and metallic ones in the direction perpendicular to it and therefore is bound to exhibit certain peculiarities. Goetz and Focke have made extensive investigations on its anomalous diamagnetism, the influence of temperature and the presence of foreign atoms in the lattice.

The outstanding event in the work on bismuth is the De Haas-Van Alphen Effect. De Haas and Van Alphen found that at temperatures of 20.4°K and 14.2°K a decrease of magnetization with increasing field strength occurred, when the field exceeded a certain magnitude. At still higher field strength the magnetization is again normal.

Magnetic anisotropy.—An increasing amount of attention has been paid to the exact determination of the values of susceptibilities along different axes in a crystal. It is mainly due to the work of Krishnan and Mrs. Lonsdale that these determinations have been made the basis of an auxiliary method for determining the structure of crystals.

Krishnan and his collaborators have studied the case of graphite and shown that the high diamagnetism displayed by it in the direction normal to the basal plane and resulting in the high anisotropy, is to be expected from the characteristic layer lattice structure of the crystal. Ganguli has further shown that the high anisotropy of graphite falls considerably when it is oxidized to blue graphite. Use has been made of these observations by the workers at Lahore in elucidating the nature of the activation of carbon. It has been shown that this process consists in the development on the surface of carbon of graphitic crystals differentially oxidized.

Magnetic susceptibility and particle size.—A problem which has aroused considerable interest is the influence of particle size on the magnetic susceptibility. Rao observed a decrease in the diamagnetic susceptibility of elements like Bi, Sb and graphite and an increase for others like Sn and Cu. Attention was drawn early by Bhatnagar to the fact that the observed effects may be due to surface oxidation, adsorption of gases, etc., or to a change in the microcrystalline structure on colloidalization. From a series of carefully planned experiments involving a rigorous control of the method of preparation of elements, their powdering, grading and chemical examination, it was shown that there is no effect of the particle size on magnetic susceptibility in the case of Bi, Sb, S, Se, Te, Pb, Cu and Sn down to about 0.4μ. Lessheim has discussed the subject at some length and has summarized the experimental evidence available and concluded that the results are in agreement with our point of view.

Molecular Diamagnetism

As a result of extensive systematic investigations of the magnetic properties of non-polar organic compounds, Pascal showed that the molecular susceptibility could be closely represented as the sum of atomic susceptibilities of all the atoms in the molecule and a constitutive constant depending on the nature of the linking between the atoms. Pascal's values have been shown to be generally fairly accurate but a critical study of his data particularly that of CH_2 group shows that a re-examination of his value is necessary. Pascal's value for the CH_2 group from an examination of the nitro compounds is -11.42×10^{-6} which is in good agreement with the figure -11.36×10^{-6} obtained by Mitra and Tuli by the aid of the magnetic interference balance from a variety of organic substances. The value obtained by Gray and Cruickshank is -11.87×10^{-6}. The lower value of Mitra and Tuli has the advantage that the molecular susceptibility for hydrogen calculated from it is -2.68×10^{-6} which is in better accord with -2.37×10^{-6}, the theoretical value for hydrogen than with -2.98×10^{-6}, the value obtained from

Pascal's data. According to the additivity law the susceptibilities of organic isomers ought to be identical but recent measurements made at Lahore have shown that small but definite differences exist between different organic isomers for example, for aliphatic isomerides the susceptibility increases in the order: primary, secondary and tertiary; for aromatic isomerides the ortho forms have the highest susceptibility. Pascal had determined the value of the constitution correction factor for a large number of organic compounds. Recently useful addition to this has been made by Kapur and Verma in Lahore, who have determined this factor for addition compounds.

Whether or not the additivity law of Pascal holds good for polar compounds as well, has been the subject of investigation of various workers during recent years. The work carried out in the writer's laboratory shows that in electrovalent salts, where the ions have complete inert gas configuration, the molecular susceptibility can be considered to be the sum of the ionic susceptibilities but in compounds of the type $HgCl_2$, CdI_2 the values obtained are slightly higher, and this may be due to their being covalent. The experimental ionic susceptibility values obtained show generally better agreement with the values calculated according to the theoretical expression for ionic and atomic susceptibilities put forward by Slater and Angus than by other investigators. The above quantum mechanical treatments have been utilized to discuss the electronic constitution of diamagnetic compounds. Although applied with success to cases where the compound behaved either as a perfect electrovalent or as a covalent one, the various plans for the elucidation of the structure have not so far been successful in cases where there is partial dissociation. Gray and Cruickshank have put forward a plan, which helps in differentiating between different structures including those involving resonance, and can be applied to cases for which no method has hitherto been available. For example, the theoretical values calculated according to this plan for the two formulæ commonly assigned to hydrogen peroxide give support to the formula $\begin{matrix}H\\H\end{matrix}\!>O \rightarrow O$ rather than to $H—O—O—H$. Recently Clow has applied this plan to the study of the much debated structure of urea and its derivatives and favours the resonating *zwitterion* structure which is an extension of the cyclic structure of Werner.

Since the discovery of heavy hydrogen, much interest has been shown in its compounds which have ceased to be chemical curiosities. One of the most useful addition to the subject has been the exact determination of the magnetic susceptibility of heavy water. Iskenderian has made the interesting observation that the molecular susceptibility values of D_2O and H_2O are $-12.95\pm0.01\times10^{-6}$ and -12.97×10^{-6} respectively, which are practically identical.

Paramagnetism of Ions, Molecules, Free and Bi-Radicals

As regards the paramagnetic molecules, the electronic theory of atomic structure assigns the paramagnetism of an ion either to the orbital angular momentum of an incomplete electron shell or to its resultant spin. In accordance with this the experimental results have shown that the ions of the transition series and of the rare earths are paramagnetic. The ionic susceptibilities of the elements of the first transitional series are given more or less satisfactorily by the expression $P_B = \sqrt{4S(S+1)}$ where S is the resultant spin; the orbital moment being rendered more or less completely inoperative. Any deviation from this suggests the interaction of the electronic orbits with the neighbouring ions to different extents in different compounds. In order to investigate this point the magnetic moments of Ni, Co, Mn, Cu-ions were determined in the author's laboratories. It was observed that both in the case of Mn and Cu-ions the experimental and theoretical values agreed well, thereby indicating the total quenching of the orbital moment. But in the case of the Ni and Co-ions the experimental values obtained varied between 2.75 and 3.2 and 4.97 and 5.37 Bohr units against the theoretical values of 2.83 and 3.87, respectively. If there is no quenching of the orbital moment, according to the expression $P_B = \sqrt{4S(S+1)+(L+1)}$ the values should be 5.20 and 4.47 for Co and Ni ions respectively. The experimental values obtained are in between the

two values calculated by the two expressions. The results indicate, therefore, the partial quenching of the orbital moment.

In the case of rare earth ions, however, the incomplete electron shell which gives rise to paramagnetism is one of the inner shells. Consequently, the contribution due to the orbital angular momentum to the paramagnetism of the ions must be taken into account. Recent observations support this view.

The ions of the transition metals of the first series have been found to be paramagnetic, but the complex salts formed by them are diamagnetic, indicating that during the process of co-ordination the unpaired electrons of the outer shells become paired and thus acquire an inert gas configuration, thereby destroying completely the momentum of the ion. Where the inert gas configuration is not acquired, the ion exhibits paramagnetism corresponding to the number of unpaired electrons. Thus by investigating the magnetic properties of copper complex compounds at Lahore a true complex formation has been distinguished from a double salt formation. The ionic magnetic moment of Cu in copper ammonium sulphate and other complex salts was found to be 1.89, exactly the same as that of Cu-ion in an electrovalent salt against the zero magneton value obtained for tetrakisethylene thiocarbamide copper nitrate. It is, therefore, to be concluded that in the copper ammonium complex the various constituents are held together by electrovalent forces, whereas in the other true complex salts the constituents which go to form the complex actually share the electrons with the central atom.

Of some general interest during recent years has been the application of this method to the elucidation of the structure of the constituents of blood. Klemm was the first to investigate the magnetic properties of porphyrin complexes, which form the basis of a number of natural products including blood. The metal complexes of porphyrin derivatives were found to be diamagnetic. If there were a salt-like combination between the metal and porphyrin, the metal complex would be paramagnetic, but because it is diamagnetic, it has to be regarded as a true complex and has been assigned the structure No. 1. On the electronic basis the structure is represented by diagram No. 2. Working independently,

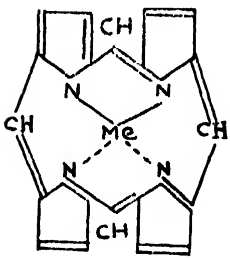

Fig. I

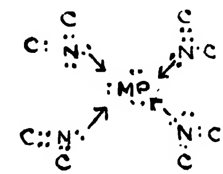

Fig. II

however, Haurowitz found that Ni compounds of porphyrin are paramagnetic and hence he concluded that the union of the metal atoms occurs by the loss of 2 electrons to the organic group. From the consideration of other properties, such as molecular volume, X ray spectrum and solubility as well, they have assigned the structure III to the metal complexes in preference to I and IV. This

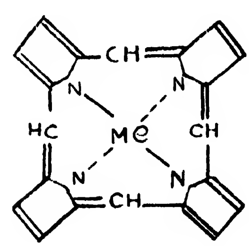

Fig. III

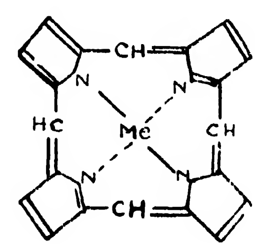

Fig. IV

controversy about the magnetic properties of Ni porphyrin complexes has been closed since the joint publication of Haurowitz and Klemm, who have recently collaborated and reported that the differences observed by them are not real. They have found the nickel salt of dimethyl mesoporphyrin to be about as diamagnetic as the parent porphyrin itself, and the nickel salt of tetramethyl hematoporphyrin, which was previously reported to be paramagnetic, becomes also diamagnetic on ageing, and have concluded that Ni-porphyrins contain no unpaired electrons.

These conclusions have recently been supported from a study of the magnetic properties of the constituents of hemoglobin by Pauling and Coryell. The authors report that globin hemochromogen, dicyanide hemochromogen, nicotine hemochromogen, pyridine hemochromogen, and Ni protoporphyrin are diamagnetic and ferriheme and ferroheme are paramagnetic showing magnetic moments of 5.69-5.93 and 5.02-4.83 Bohr magnetons respectively. These magnetic measurements correspond to five unpaired electrons for ferriheme, four for ferroheme and zero for the rest. The presence of unpaired electrons in ferri- and ferrohemes indicates, therefore, that the iron atom is attached to the four adjacent nitrogen atoms of the porphyrin not by covalent bonds but by ionic bonds. On the other hand, the presence of no unpaired electrons in the other four hemochromogens indicates that the 3d orbitals of the ferrous iron atom are involved in the formation of covalent bonds and that the iron atom is accordingly attached by essentially covalent bonds not only to the four porphyrin nitrogen atoms but also to two other atoms giving an octahedral arrangement of six atoms about the iron atom. Continuing their investigations on hemoglobin, oxyhemoglobin and carbon monoxyhemoglobin, Pauling and his collaborators have studied the magnetic properties of ferro-hemoglobin and hydroxide, hydrosulphide, fluoride and cyanide of ferrihemoglobin. Both the oxy- and carbon monoxyhemoglobin are found to be diamagnetic and hence to have no unpaired electron indicating that the ferrous iron atom is involved in the formation of six octahedral covalent bonds, four to the porphyrin nitrogen atoms, one to an atom (probably nitrogen) of the globin and one to the carbon monoxide in case of carbonmonoxy and to the oxygen in the case of oxyhemoglobin. The magnetic susceptibility of ferrohemoglobin corresponds to an effective magnetic moment of 5.46 Bohr magneton, of ferrihemoglobin to 5.80, of ferrihemoglobin fluoride to 5.92, of ferrihemoglobin hydroxide to 4.47 and of ferrihemoglobin hydrosulphide and cyanide to 2.26 and 2.50 respectively. The magneton values for ferrihemoglobin cyanide and hydrosulphide correspond to one unpaired electron per heme, indicating essentially covalent bonds; for ferrihemoglobin and its fluoride to 5 and for ferro to 4 indicating essentially ionic bonds; and for the hydroxide to three indicating bonds of an intermediate type.

It would not be out of place to mention here that over ninety years ago Faraday investigated the magnetic properties of dried blood and made a note " must try fresh blood." Had he then determined the susceptibilities of oxygenated and deoxygenated blood he would have found, as Pauling and his collaborators have now discovered, a considerable difference between them and the subsequent researches on blood and hemoglobin would have been considerably influenced by that observation.

Hemmett and Walden as a result of similar magnetic measurements on phenanthroline ferric complexes determined the nature of linkages of the Fe-atom with the rest of the phenanthroline molecule. Klemm and his collaborators have employed this method extensively to distinguish between the true and the loose complexes formed by the metals of the transition group of the first series. They could not, however, apply with much success this method to the complexes of the higher members of the transition series, because of the incomplete quenching of the orbital moment due to the less interaction of the larger ions with the neighbours.

The magnetic properties have been ingeniously employed to decide controversies regarding structures in many complexes. Asmussen, from a study of the magnetic susceptibility of ferrous tetrapyridine dithiocyanate proved Rosenheim's view to be incorrect. Klemm and Werth from a study of the magnetic susceptibility of red and blue varieties of perchromates showed that Cr in the red variety is pentavalent whereas it is hexavalent in the blue variety.

Study of paramagnetic substances in solution.—A study of the magnetic properties of solutions of the salts of the transition series has thrown much light on the nature of the physical and chemical changes that take place during the process of solution. For some ions the susceptibility constant remains unaltered when they go into solution indicating that there is no chemical change. The

case of Mn salts investigated at Lahore may be cited as an example of this behaviour. For others it varies with concentration indicating a chemical change. Examples of this are furnished by cobalt salts, which by their striking changes of colour and magnetic behaviour support the view that complex ions of the type $CoCl_3$ and $CoCl_4$ are formed. Investigations by Sugden and Barkworth on similar lines suggest the formation of complex ions of cobalt in bispyridyl cobaltous chloride.

Free and bi-radicals. Magnetic measurements have also yielded valuable information regarding the existence of "free radicals", namely the molecules containing an odd number of electrons. If the moment in such molecules be due to spin only, as in the case of ions, the value of μ_B calculated from $2.84\sqrt{\chi_M(T-\theta)}$ would be 1.73 Bohr's unit. This has been shown to be true for such compounds as NO, NO_2, ClO_2 and ClO_3. The feasibility of this principle has been abundantly proved recently by Sugden and Muller. Sugden and his co-workers studied a number of such compounds and found that they were strongly paramagnetic but with an effective magnetic moment rather less than the calculated one. This discrepancy was attributed to the presence of diamagnetic undissociated molecules. In contrast to these in many compounds studied by Muller and his collaborators, the experimental value agrees with the theoretical one.

The corresponding dimeric molecules of these free radicals are, however, diamagnetic. The magnetic method has been used by Muller to determine the degree of dissociation of such compounds as hexaphenyl ethane and hexa-aryl substituted ethane and the results obtained are in very good agreement with those obtained by the optical method of Ziegler and Ewald. Recently Farquharson has determined the degree of dissociation of Cl_2O_6 both in the liquid and the solid states from magnetic measurements.

It should be possible with the help of magnetic measurements to prove the existence of bi-radicals, *i.e.*, such substances as have two free linkages due to two unlinked electrons which do not interact with each other. The spins of the free electrons should not compensate each other, and at room temperature, ought to have an effective magnetic moment of 1.73 for each half of the molecule. Many compounds which on account of their colour and chemical properties have been supposed to be bi-radicals, have failed to satisfy the magnetic test and the only exceptions are porphyrindine and *m-m'*-diphenyl methyl.

Sugden recently observed that thiobenzophenone, which from its chemical and physical characteristics has been supposed to be a bi-radical, is diamagnetic. He, therefore, made the suggestion that probably the spins of the two free electrons are opposed to each other resulting in the destruction of paramagnetism and from this he concluded that the magnetic test may not be a decisive one for bi-radicals. This view is, however, open to the objection that the word bi-radical has recently been exclusively applied to those molecules which have two free valencies independent of one another.

Since it has been established that "odd" molecules are invariably paramagnetic, the magnetic method has been used to elucidate the electronic structure of compounds and also to decide in other cases whether those compounds should be represented by the simple or the double formula. Lowry assumed the existence of single electron linkage in Me_2TeX_2, where X is Cl, Br or NO_3, but the magnetic investigations carried out at Lahore show that there is no evidence of the existence of single electron bonds in such compounds. Klemm found the sodium salt of hyposulphurous acid to be diamagnetic. He assigned to it therefore the formula $Na_2S_2O_4$ as against $NaSO_2$ the generally accepted formula, which would make this substance paramagnetic. Sugden from similar investigations represented hypophosphorous acid as $H_4P_2O_6$ and Klemm represented a compound formed by the interaction of alkali metal and B_2F_6 as $K_2B_2F_6$ against KBF_3.

Polymerization

Valuable information on the question of polymerization can also be obtained from magnetic measurements. Change in mass susceptibility on polymerization was observed at Lahore in anthra-

cene, acetone, benzaldehyde, furfurol and acetyl cyanide. Farquharson argued that for *n*-fold polymerization of the molecule *B* the susceptibility of the polymerized molecule will be

$$\chi_n = n\chi_B + (n-1)\lambda$$

where λ is the constitutive correction factor for polymerization; the mass susceptibility of the polymerized molecule is then $\chi = \frac{n\chi_B + (n-1)\lambda}{n M_B}$

where M_B is the molecular weight of the simple molecule. If λ is known, the degree of polymerization can be measured continuously by following up the change in the mass susceptibility. In the study of such reactions as the polymerization of dimethylbutadiene and *cyclo*-pentadiene, in which each stage involves the elimination of a double bond, Farquharson observed a progressive change in the magnetic susceptibility. Recently the magnetic data of polyoxymethylenes, the polymerized products of oxymethylene diacetates have been employed to determine the $-CH_2O-$ groups in polyoxymethylenes.

Magnetic Properties in Relation to Phase Equilibrium

From an extensive study of the magnetic properties of various phase rule equilibria it has been found possible to formulate certain rules which provide very useful information regarding structure, formation of intermediate compounds, etc. These generalizations have been used by Svensson in detecting several PdH-Pd alloys in the Pd-H system, by Stephens and Evans in establishing the formation of compound Ag_3Sb in the Ag-Sb system only and not in the Ag-Pb or the Ag-Bi systems and by Fallot in detecting the presence of certain superstructures in various iron alloys. Magnetic properties of amalgams, however, did not attract the attention until recently. The author found dilute copper amalgams to behave as mechanical mixtures and Bates and Tai, while studying the magnetic properties of amalgams of Mn, Bi, Cr and Cu, found that with the exception of copper all the metals which are diamagnetic in the solid state become paramagnetic in dilute amalgams. Venkatramiah recently observed that very dilute amalgams show slight paramagnetism. His results are, however, open to the criticism that while calculating the susceptibility of amalgams, the value of copper employed by him is that given in the International Tables and not the one observed under the conditions of amalgam formation. It has been observed at the Lahore laboratories that if the experimental values in these conditions be used, dilute amalgams follow the observations of Bhatnagar and Bates. Magnetic properties of alloys have been employed in determining the atomic moments of elements when allowed with different metals. Gustafsson has recently determined the atomic moment of Mn when alloyed with Cu, Ag and Au. Fallot has determined the atomic moment of Fe when alloyed with Pt, Si, Al, Cr, Au and Sn and observed the variation of atomic moment of Fe in different alloys. These variations of atomic moment in ferromagnetic alloys are readily explained on the basis of a collective electron treatment of ferromagnetism, which is being actively developed by Slater, Mott, Stoner and others.

Not only in alloys, but also in compounds the magnetic susceptibility has been studied in relation to phase rule equilibria. The author examined the magnetic properties of solid solutions of $KMnO_4$-$KClO_4$, KCl-NaCl, KBr-KCl and KBr-NaBr and found that in the system $KClO_4$-$KMnO_4$ the susceptibility concentration curve is a straight line, while the other systems yield curved graphs. The abrupt change of slope in the susceptibility-concentration curve has been recently made use of by Haraldsen and his collaborators in detecting the appearance of a new phase particularly in systems in which one component is diamagnetic and the other is ferromagnetic. An interesting example is found in the system CoS-S in which addition of sulphur brings about no change in the magnetic susceptibility until the composition $CoS_{1.3}$ is attained when a strongly paramagnetic phase CoS_2 appears. Similar behaviour has been observed in the system Cr-S.

Influence of the Magnetic Field on Homogeneous and Heterogeneous Equilibria

The magnetic field has been found to influence the course of a chemical reaction. The subject

has been critically examined by the author in the treatise on Magnetochemistry and from the data then available the conclusion was drawn that a reaction would be accelerated, retarded, or remain unaffected according to whether the sum of the molecular susceptibilities of the products is more than, less than or equal to the sum of the molecular susceptibilities of the initial substances.

The influence of the magnetic field on the phenomenon of adsorption has also been investigated in the author's laboratories. It has been observed that the difference in adsorption inside and outside the fields depends on the field strength applied. Investigations of this type have already provided valuable information regarding the mechanism of adsorption.

Catalysis and Magnetic Properties

It has been observed that a study of the magnetic properties of the catalysts may yield valuable clues to the theory of catalysis. Hedvall, Hedin and Persson, while studying the reaction $2N_2O \longrightarrow 2N_2 + O_2$ using Ni as a catalyst, observed that the rate of decomposition is suddenly increased above the Curie point, although the X-ray investigations by Nunzio do not indicate any difference between the lattice structure of Ni above and below the Curie point. Experiments repeated with samples having different Curie points also indicated an increase in the reaction velocity above the corresponding temperature.

An extension of the work by Hedvall and others has shown that the hydrogenation of carbon monoxide and acetylene by Ni and the formation CO_2 from CO by Heusler's alloys is much accelerated at the Curie points. The changes involved in the catalysts are also partly structural.

The fact that catalytic activity may have some relation to the magnetic behaviour, was also confirmed in an extended investigation by Taylor and Diamond, who found that the spin isomerization of hydrogen at low temperatures is much more catalysed by a paramagnetic surface than by a diamagnetic one. Even in cases where the bulk of the material is diamagnetic, the catalytic activity is attributed by them to a paramagnetic surface. This idea, though rather far fetched, would certainly require further investigation.

Magneto-optical Analysis

Allison and Murphy's magneto optical method of chemical analysis, which depends on the investigation of the time-lag of the Faraday effect behind the magnetic field as a function of the wave-length of the light used, has been the subject of much controversy during recent years. Hughes and Goslin, Wissink and Woodrow have used this method extensively for detecting the localization of metals in organs and to detect vitamin A; whereas Jepperson and Bell regard the results obtained to be due to physiological and psychological effects.

Photomagnetic Effect

It is desirable in this survey to include also an account of what may be termed the photomagnetic phenomenon. Light brings about a number of physical, physico-chemical or chemical changes; the magnetic study of these effects should be of considerable value in explaining the nature of the changes involved. During the last few years attention has been paid to the magnetic study of photo-phenomena to justify the treatment of the results under a separate head.

Heaps investigated first the magnetic properties of illuminated silver chloride and selenium and showed that no change in the magnetic susceptibility takes place on solarization. Some preliminary experiments on the magnetic behaviour of silver halides have been carried out in the author's laboratories and it has been shown that a change in magnetic susceptibility takes place when these substances are exposed to sunlight for extended periods. Change in the magnetic susceptibility in the case of iodide can quantitatively be accounted for satisfactorily, if it is supposed that the halide decomposes into the metal and the halogen. The whole subject is at present under investigation.

Another of the vexed problems of photo-chemistry is the phenomenon of phototropy. Phototropic substances are known to undergo a change in colour on exposure to light of a suitable frequency. This change in colour is completely or partially reversible when the exposed substances are kept in the dark for sufficiently long time, heated or re-crystallized. Generally this phenomenon is not

accompanied by any change in physical properties like melting points, crystal structure, etc. Measurements of the magnetic susceptibilities of phototropic anils, hydrazones, semi-carbazide and anthracene have been carried out before and after exposing them to sunlight in the author's laboratories. The value of the exposed and unexposed samples was found to be the same, except in the case of anthracene where the change is due to photo-polymerization.

From the rate of colour development Padoa suggested the mechanism:

$$A_2 \underset{\text{Dark}}{\overset{\text{Light}}{\rightleftharpoons}} 2A$$

for benzaldehyde phenylhydrazone and salicylidene-α-naphthylamine. But it seems more reasonable, as was pointed out by Senier and Shepheard, to assume that this change which is reversible is due to a modification in the aggregation or sizes of particles. If that is so, no change in the magnetic susceptibilities may be expected, which is in accord with the experimental facts.

Emberson and Dufford have also looked for a photomagnetic effect in photovoltaic substances and shown that no change in magnetic susceptibility takes place on exposure to light. They suggested that either the magnetic susceptibility is not dependent on the number of free electrons or more probably the photovoltaic effect does not involve the liberation of free electrons.

There are, however, a number of cases where exposure to light has definitely been shown to bring about a change in the magnetic susceptibility, the effect being more or less explicable on theoretical grounds. Bhuyan observed that halogen molecules show an increase in magnetic susceptibility on exposure to light. Although on theoretical grounds the halogens may be expected to be adiabatically dissociated into atoms in the $^2P_{3/2}$ and $^2P_{1/2}$ states, both of which ought to be para-magnetic, the increase in diamagnetic susceptibility observed is probably due to the large number of excited molecules. This is borne out by the observation that the change is completely reversed on taking away the light source.

Bose and Raha have recently extended their earlier work on photomagnetism and found that a positive effect is shown by solutions of vanadium ions in different valency states and by crystals of $NiSO_4.7H_2O$. This effect decreases in the order of $Ni^{\cdot\cdot}$, $Cr^{\cdot\cdot\cdot}$ and $Co^{\cdot\cdot}$ and is absent in the solutions of Cr and Ni in hydrochloric acid.

In order to explain their observations Bose and Raha have assumed a sort of loose chemical combination between the molecules of the solvent and the paramagnetic ion, which breaks down on exposure to light. They have concluded that, if the orbital moment is equally quenched in the initial or the final states as in the case of $Cr^{\cdot\cdot\cdot}$ and $Ni^{\cdot\cdot}$ in HCl, no photomagnetic effect would be observed. The positive effect in the other substances should be attributed to the quenching of the orbital moment. A further study of this effect is bound to be of considerable interest at least from the point of view of the much vexed question of the theory of solutions.

Under the head of photo-magnetic phenomena, the phenomenon of extinction of fluorescence under the action of the magnetic field may also be included, which was observed and studied by Genard in a series of papers. It has been shown that fluorescence excited in the vapours of I_2, S_2, Se_2 and Te_2 by a suitable frequency is considerably and sometimes entirely removed by a magnetic field. On close analysis it has been shown that terms of the same series and quite often the components of the same multiplet are differently affected; the fluorescence of some lines is reduced, and of others is enhanced. In the case of iodine, Genard has concluded that probably an electronic level exists between $^1\Sigma_g^+$ and $^3\pi 0 u$ This is in agreement with Van Vleck's theory. Zeeman effect alone cannot explain this phenomenon.

I hope I have succeeded in showing some of the interesting and fascinating features of this subject.

In concluding this survey, I cannot help hoping that this historic meeting will help us in forging new bonds of personal magnetism which will lead to further advances in Physics and Chemistry and to the cementing of the relation between the East and the West and the old and the new worlds.*

* Based on the Presidential Address delivered by the author before the Section of Chemistry of the Silver Jubilee Session of the Indian Science Congress held in January 1938 at Calcutta.

The Nature of Toxins and Antitoxins and their Mutual Reaction

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It has long been known that a high proportion of the total sickness in man and animals results from infective disease where bacteria and other microbial parasites gain access to the hosts' tissues, multiply in them, and cause harmful effects. Of these, some of the bacteria produce their effects by the local production of a powerful toxin which passes into the tissues and produces its toxic effects on cells remote from its origin. Others produce their main pathological effects at the site or sites in which they are multiplying. Among the bacterial toxins there are some which are characterized by the ease with which they may be separated from the bacterial cells which produce them under suitable conditions and in a suitable fluid medium, by passing through candles or by filtration through seitz filters. These toxins are referred to as exo-toxins. There are other toxins which are characterized by remaining incorporated in the substance of the bacterial cells. They can be obtained in a state of solution or perhaps suspension only by methods which result in the disintegration of the bacterial cells. They do not in general exert any characteristic pharmacological action by which they can be differentiated from one another. They are relatively stable to heat withstanding temperatures of 80-100°C for an hour or more. They are referred to as endotoxins. The minimum lethal doses of potent diphtheria and tetanus toxins for guinea-pigs as generally obtained are respectively 0.001 c.c. and 0.0000025 c.c. It is, however, reported by workers in other laboratories that they obtained tetanus toxins of M.L.D. 200,000 per c.c. The M.L.D. of botulinus toxin is 0.001 c.c., whereas in the case of gas gangrene and staphylococcus, the doses required to kill mice are very large. We have not yet been able to isolate toxins in a pure state, and we often refer to toxins as active secretions of bacterial cells. This popular definition of toxins is misleading for the following reasons.

There are some so-called exo-toxins, *e.g.*, gas gangrene, which are produced in high concentration during the phase of active bacterial growth. This may be called active secretion product. But other toxins, for example, those of diphtheria and tetanus, are obtained in high concentration in a fluid culture when the phase of active growth has passed and the majority of micro-organisms present are dead or dying. So, how far the autolytic process may be concerned in toxin production is uncertain. We have in fact no real knowledge of what toxins are or how they are produced.

The specific mechanism for the production of a particular toxin may possibly be determined by an elaborate study of the chemical changes undergone by the culture media and also by the physical and chemical changes undergone by the bacteria themselves in the course of the production of the toxin.

For the time being it is safe to call exo-toxins those substances, which are obtained free from specific bacteria by filtration and without applying any mechanical means for the disruption of the bacteria and which are distinguished from each other by their specific pharmacological actions.

Antitoxin is a substance which is produced in the serum of animals like horses, mules, buffaloes, etc., by injecting gradually increasing doses of toxin, and which possesses the capacity of combining with the toxin specifically. Antitoxins are proteins in nature and are generally found to be associated with the pseudo-globulin fraction of the blood serum. It is now usually believed that an antitoxin is a new globulin synthesized under the

directing influence of antigen. This influence is exerted through a combination of the peptides or amino-acids with the active groupings of the toxin during the globulin synthesis. Breinel and Haurowitz would locate this synthesis in the reticulo-endothelial cells, the antitoxin globulin being released when these cells disrupt.

This hypothetical localization would at least accord quite well with our knowledge of the activity of the reticulo-endothelial system.

Physical Chemistry of Toxins and Antitoxins

Before discussing the theories of toxin-anti toxin reaction it may be worth while to say a few words regarding the methods of measuring the potency of the toxins and anti-toxins.

In the case of diphtheria and tetanus toxins, there are three units, by which the potency can be expressed.

(1) The M.L.D. is the least amount of toxin that will on the average kill a guinea-pig of suitable weight within four days after subcutaneous inoculation.

(2) The L_0 dose of toxin is the largest amount of toxin which when mixed with one unit of antitoxin and injected subcutaneously into a guinea-pig of proper weight, will on the average give rise to no observable reaction, local or general.

(3) The L_+ dose of toxin is the smallest amount of toxin which when mixed with one unit of antitoxin and injected subcutaneously into a guinea-pig, will on the average kill that guinea-pig within 4 days.

Then from the above definitions we may expect that, $L_+ - L_0 = 1$ M.L.D. for a given toxin. In fact it is not so. When mixtures of various amounts of toxins with one unit of antitoxin are tested by subcutaneous injections in the guinea-pig, the difference between L_+ and L_0 lies any where between 10 and 100 M.L.D.

Again, if to an L_0 dose of toxin varying amounts of antitoxin are added and the amount of unneutralized toxin in each mixture is determined by *in vivo* tests, it is found that the amounts of toxin neutralized by different fractions of one unit of antitoxin are not proportional to the fractions employed. As the amount of antitoxin in the mixture is increased, equal increments neutralize proportionately less and less toxin, until, when one unit has been added, complete neutralization is attained.

Danysz Phenomenon

It has been observed that if a constant amount of toxin is added to a constant amount of antitoxin the toxicity of the mixture varies according to the way in which the addition is made.

If, for instance, 1.0 c.c. of toxin, which is completely neutralized by 1.0 c.c. of antitoxin when added in one instalment, is added to the same 1.0 c.c. of antitoxin in two or three instalments at intervals of, say, 15 minutes, the mixture becomes highly toxic. Further addition of antitoxin is required to make such a mixture non-toxic.

Theories of Toxin–Antitoxin Reactions

There are three classical theories regarding the machanism of toxin-antitoxin reaction, which have received extensive consideration. These theories have been formulated by Ehrlich, Arrhenius and Madsen, and Bordet. None of these theories, however, appears to explain fully all the phenomena regarding toxin-antitoxin reaction.

Ehrlich considered the reaction as a simple and irreversible chemical reaction similar to that of a strong acid with a strong base. But when experiments were undertaken to standardize toxins and antitoxins he found it necessary to postulate the existence of a modification of toxin which retains its combining affinity after losing its toxicity. This modified toxin was termed toxoid. Later, Ehrlich had to modify his theory by postulating the existence of not one but a number of toxoid-like substances, so that the theory of a simple chemical reaction was lost in the confusion of explanatory details. But the terms toxoid, protoxoid, etc., with different affinites (less or greater than that of toxin) for antitoxin are retained for practical advantage. It has been found that a neutral mixture of toxin and antitoxin may be made highly toxic by adding a very small quantity of toxoid.

THE NATURE OF TOXINS AND ANTITOXINS AND THEIR MUTUAL REACTION

Arrhenius and Madsen tried to explain the quantitative relations of toxin-antitoxin reactions with the help of the law of mass action. They compared toxins and antitoxins to weak acids and weak bases respectively and, assuming that a single molecule of toxin unites with a single molecule of antitoxin to form two molecules of toxin-antitoxin compound, deduced the following equilibrium equation

$$(T)\ (A)=K\ (TA)^2$$

They justified their idea of toxin and antitoxin reaction as similar to that between a weak acid and a weak base on the basis of a close analogy which they found in the progressive neutralization of the haemolytic action of ammonia by the addition of increasing amounts of boric acid. Their theory also suggests that in order to eliminate all free toxin it would be necessary to add more than an equivalent amount of antitoxin, thereby accounting for the discrepancy between L_0 and L_+ dose. The curve of partial neutralization is also partly though not completely realized by their equation based on law of mass action. The weakness of their theory lies in the fact that it cannot explain the Danysz phenomenon in a proper way. Arrhenius and Madsen tried to explain it by suggesting that an intermediate reaction prevents the completion of the original reaction when the final fraction of one of the reagents is added. But this intermediate reaction is hardly detectable experimentally.

Bordet denies the applicability of the laws of ordinary chemical union, since the law of chemical combination in definite proportions is not followed by toxin-antitoxin reactions. He considers the reaction between toxin and antitoxin as a purely colloidal reaction, in which the conditions determining the quantitative relationships are physical rather than chemical. He assumes that when an antitoxin is added to a toxin, there is a partial neutralization of each particle of toxin by antitoxin instead of the neutralization of progressively large amounts of the toxin until all is neutralized by antitoxin. Considering the reaction as an adsorption phenomenon, Biltz used the empirical adsorption equation of Freundlich to explain these phenomena. If x is the amount of substances adsorbed by an adsorbent of mass m, c is the concentration of the substance left in the fluid at equilibrium and a and n are constants, then

$$\frac{x}{m}=ac^n$$

or $\log x-\log m=\log a+n\log c$

If x is taken to represent adsorption per unit mass, we get

$\log x=\log a+n\log c$

The Freundlich isotherm gives a fair fit to the adsorption curves over a wide range. Since the amount of toxin adsorbed or neutralized by one unit of antitoxin will depend on the concentration of the toxin in the reacting mixture, the Bordet theory accounts for the L_t-L_0 discrepancy and also the results obtained in the partial neutralization of toxins. Bordet's theory also accounts for the Danysz phenomenon satisfactorily. The main drawback of this theory is that it ignores the specificity and that it lacks a quantitative formulation on a theoretical basis. Recently these defects in the theory have been largely eliminated by some modifications introduced by Ghosh. On the basis of certain assumptions in which the specificity of antigen-antibody combination has been taken into consideration, Ghosh has deduced the following two equations:

$$(1)\quad C-P=C-\frac{(K+C+TN)-\sqrt{(K+C+TN)^2-4TNC}}{2}$$

$$(2)\quad P=\frac{-K+\sqrt{K^2+4KC}}{2}$$

where C is the total number of units of antigen initially taken, P is the units of antigen adsorbed when equilibrium is reached, and K, T and N are constants. He assumes that on the surface of the antibody particles there are a certain number of active points where the particles of the corresponding antigen can be adsorbed in preference to other substances that may be present in the solution. Since an anti-body is synthesized by the defence organisms of an animal in response to stimulation by the corresponding antigen, it is quite conceivable that its surface should be especially suited for the fixation of the particular antigen.

THE NATURE OF TOXINS AND ANTITOXINS AND THEIR MUTUAL REACTION

The validity of the equations (1) and (2) has been tested on the data collected by various investigators, and they are found quite satisfactory.

That the toxin-antitoxin reactions are purely colloidal is justified from the fact that both the reagents are colloids as will be seen afterwards.

The following is a short summary of the modern conceptions regarding the mechanism of toxin-antitoxin reactions. It is now believed that these reactions depend on specific affinities determined by chemical structure of the nature and spacing of active groupings in relation to one another. The quantitative behaviour of these reactions depends on a variety of factors, one of which is considered to be the complexity and large molecular size of the reacting substances. These are supposed to contain many combining groups which combine in varying proportions depending on conditions. The complexes formed are dissociable to a varying degree. Since combination may occur in stages, it is also possible that some secondary change in the antigen-antibody complex produced in the earlier stages may alter its capacity for further reaction. Again the combination between toxin and antitoxin may become firm with lapse of time. So the quantitative relations that are found in toxin-antitoxin reactions appear to be determined by highly complex factors.

Colloidal Nature of Toxins and Antitoxins

The colloidal nature of toxins and antitoxins has been established by a number of workers. They can be dialysed in collodion membranes, and their solutions possess high viscosity and low osmotic pressure. Biltz, Much and Siebert applied to immune sera and toxic broths the electro-colloidal reactions of inorganic and organic colloids. They found that tetanus toxins and antitoxins were precipitated by positive inorganic colloids.

In a U-shaped cataphoretic tube, toxins and antitoxins migrate to the anode in alkaline solution having a pH 4.6. This suggests that an antitoxin is an amphoteric colloid.

Since like the proteins, toxins and antitoxins are attacked by enzymes, precipitated by $(NH_4)_2 SO_4$ and salts of heavy metals and are sensitive to all reagents which alter the natural proteins, it may be suggested that they are of protein nature. The colloidal character of toxin-antitoxin reactions has received further support by the recent discovery of Ramon's flocculation test. Ramon first observed that of a series of mixtures of toxin and antitoxin mixed in varying proportions the neutral mixture flocculates first. The reaction is analogous to the mutual coagulation of two oppositely charged colloids when they are mixed in suitable proportions.

A Correction

In "SCIENCE AND CULTURE; February, 1938, p. 432 column 2, line 42 *for* "experiments in respect of the problem of gravitation" *read* "Michelson-Morley's experiments".

Notes and News

An Outline of the Field Sciences of India

The publication of *An Outline of the Field Sciences of India* by the Indian Science Congress Association is very welcome as a guide to a proper appreciation of the various field problems involved in the study in India of such subjects as Meteorology, Oceanography, Geology, Botany, Zoology, Ethnology, Agriculture, Animal Husbandry, and Archaeology. It was originally meant for the foreign delegation of the Silver Jubilee of the Indian Science Congress held at Calcutta in January last 'to enable them to make the best use of their short sojourn in this country' and 'to help the delegates to study any particular problem, in case they wished to do so, on the spot.' A glance at the pages of the publication will, however, reveal that it will not only serve as a guide and a companion to all those who may wish to employ their leisure hours in the pursuit of the Field Sciences in this country, but will also enable the specialists in various branches of Science to appreciate the problems of sister sciences. The publication is edited by Dr S. L. Hora of the Zoological Survey of India, who is the honorary treasurer of the Indian Science Congress Association. It contains 8 chapters, each chapter dealing with a particular branch. The subjects dealt with are: (1) The Weather of India by C. W. B. Normand, (2) The Oceans round India by R. B. Seymour Sewell, (3) An Outline of the Geological History of India by D. N. Wadia, (4) An Outline of the Vegetation of India by C. C. Calder, (5) An Outline of the Fauna of India by H. Srinivasa Rao, (6) An Outline of the Racial Ethnology of India by B. S. Guha, (7) Agriculture and Animal Husbandry in India by Bryce C. Burt, and (8) An Outline of Archaeology in India by K. N. Dikshit. It will be seen that each chapter has been written by an authority on the subject and, as such, commands close attention. We agree with the editor of the publication that a composite publication of this nature is likely to have a wide influence in creating a broader outlook in the study of 'Science' as a whole, and may help to bring about a certain amount of cooperation between workers in different branches, which is so desirable for the advancement of Science in these days of specialization and which is one of the main objects of the annual meetings of the Indian Science Congress Association.

School Hygiene Scheme

According to a Press Note, there are signs which indicate that the School Hygiene Scheme introduced by the Government of Bengal a few years ago as an experimental measure in the Government and aided schools has been very successful. It has also been found to be gaining in popularity both amongst students and the public. The average health of the Bengali student is proverbially delicate. From their practical experience covering a number of years the officers in charge of medical inspection in schools are convinced that the problem of improving the health of students should be tackled when the boys are at school as at that tender age they are in a pliable condition of health and are easily amenable to treatment and correction of defects. They therefore propose that the hygiene scheme be made compulsory, in the interests of the health of boys, in all recognized schools in Bengal, where all boys should, in their opinion, be examined medically atleast once a year and the attention of the boys and their guardians drawn to the defects at least twice in the year. The diseases generally found in school boys in this province are those of the eye (28%), tonsil (15%), teeth (10%), digestive system (25%), and malnutrition (27%). Some other minor diseases are also common. The cooperation of guardians is essential and they should appreciate the value of the notification cards sent to them acquainting them with the nature of health and defects, if any, in their wards, and take prompt action in the matter. The medical officers consider it highly desirable that a compulsory tiffin scheme should be introduced in all schools. The tiffin must be cheap and at the same time wholesome. Above all it should cover all the proximate principles of food, and yield at least one-

eighth of the total calorie requirement for the student. This scheme proposed for Bengal may with advantage be introduced into the schools of other provinces as well, in case they have not already done it.

Annual Report of the Imperial Library

The following summary of the annual report of the Imperial Library, Calcutta, for 1936-37 makes an interesting reading:

Literature, History and Law continue to occupy the first three positions, whereas Science (General) has displaced Biography for the fourth place, the number of books consulted in this subject being approximately three times that of the preceding year. Religion has perhaps come to stay at the eighth place; Education and Geography and Travels have attained fairly high positions, being sixth and seventh respectively. For the purpose of this analysis, subjects have been classified under 34 heads, and Literature, History and Law, which occupy the first three positions, come out with 10,989, 1,760, and 1,750 requests respectively. On the whole there is a general rise in the number of books consulted, except in the case of Economics, where the number has fallen. This fall, says the report, is a little surprising, as Economics at one time occupied the third or fourth position in the scale of popularity. The rise is specially marked in the case of Archaeology, Astronomy, Education, Law, Literature, Philosophy, Religion and Science. Zoology is again last in the list, a position which it has occupied for the last few years, while Numismatics, which was its companion two years ago and went up by two places last year, has come down again to be its neighbour. Sports and Games have gone up by one step, being now the third from the bottom.

That more extensive use is being made of the Library than hitherto is evident from certain other interesting figures supplied in the report. Besides the publications available in the Reading Room for reference and study, the number of volumes supplied to readers from the Stack-Room during the year came up to 40,879 with a daily average of 116, as against 29,060 of the previous year with its daily average of 83. The total number of persons who visited the Reading Room was 50,576, the daily average of readers being 143. The number of research workers who availed themselves of the facilities of the Private Reading Room was 23; workers came, besides Bengal, from Bombay, Bihar, Orissa, the United Provinces, the Punjab and the United States of America. Among the Universities represented by these scholars were those of Lucknow, Dacca, Calcutta and Long Island. From the Lending Section in all about 12,000 volumes were lent out, as against a little over 13,000 volumes lent in the previous year. This decrease in number is chiefly due to a smaller number of books having been lent to Government offices and similar places. So far as borrowing of books by scholars is concerned, there has not been any diminution of interest. An analysis of the number and percentages of the books lent out to various Provinces shows that Bengal, excluding Calcutta, borrowed 11 books out of every 100 lent out, while all the other Provinces combined took only about 13. Calcutta alone took 76, as against 71 in the last year.

New additions made to the Library during the year number 8,267 or 453 more than during the preceding year. Of these 754 were presented to the Library, 496 were received from the Bengal Library, 1,069 were added by purchase, while the remaining 5,948 were official publications. A linguistic analysis of the additions made by purchase and presentation, other than of official publication, shows that the largest addition namely 1,455 was made in English; Bengali comes next with 307 and Sanskrit third with 136. Amongst other additions, there were 78 in Urdu, 32 in Hindi, 36 in Arabic, 49 in Persian, 13 in Pali, 70 in Spanish, 40 in French, 32 in German and 17 in Dutch. About 50,000 volumes were shelf-listed during the year. Thus, at the end of February 1937, when the temporary staff engaged for the purpose was discharged, 1,42,610 volumes had in all been shelf-listed and 70,970 cards written. Some noticeable improvements have been made during the year in the Reading Room. The seating arrangement has been changed, with the result that not only has the number of seats been increased by about a dozen to 96, but the new arrangement also affords better supervision of readers and provides ample space along book racks for readers to walk about. Another improvement is the new arrangement for exhibiting periodicals. These are no longer laid on tables, but instead have been arranged in two racks specially made for the purpose. Each rack has three small shelves in each row, with a capacity to hold 75 periodicals. These shelves are

numbered serially and the periodicals are given corresponding numbers. An alphabetical list of periodicals contained in the racks has been provided, and this helps the reader to locate the journals he is looking for. This arrangement, it is said, is appreciated by readers.

Calcutta Corporation and the Question of Electricity Supply

Several times in the past we dwelt on the question of supply of electricity in this country in general and in Calcutta in particular. We gave reasons and quoted statistics to show that the rates charged in this country for domestic supply of electric current were inordinately high. What we then said has been amply corroborated in other quarters, and Dr B. B. Dey, Chief Engineer of the Calcutta Corporation, issued a detailed statement which went to support us. It will be remembered that the Calcutta Corporation have been for a long time devoting a good deal of attention to the problem. It is due to the persistent efforts on the part of the Corporation and vigorous public agitation, both in the press and on platform, that the rate of electricity was reduced from 3 annas to 2 annas per unit in Calcutta. But it has been several times shown that the rates can be still reduced, easily to one anna per unit for domestic consumption.

On the 17th September last, the Corporation, therefore, addressed a letter to the Government of Bengal soliciting sanction for purchasing such of the electrical undertakings as were within the municipal limits of Calcutta. On the 29th January last the Government replied, refusing the sanction. The reasons given by them are not only absolutely unconvincing, they are, in the words of the *A. B. Patrika*, "beautifully vague." If "in the vital interests of the public," the Government find it difficult to give the required sanction to the Corporation of Calcutta, they should, we cannot help pointing out, take steps, also "in the vital interests of the public" to force the Calcutta Electric Supply Corporation to lower their rates of supply, or in the alternative, to do away with its monopoly in the matter of supply of electricity, cheapness of which is essential, in these days, for national progress. And national progress must be the primary concern of any civilized government.

British Association Meeting for 1938

The 1938 Meeting of the British Association for the Advancement of Science will be held in Cambridge from August 17 to 24 under the presidentship of the Rt. Hon. Lord Rayleigh, F.R.S. The following sectional presidents have been appointed: A. *Mathematical and Physical Sciences*—Dr C. G. Darwin, F.R.S.; B. *Chemistry*—Prof. C. S. Gibson, F.R.S.; C. *Geology*—Prof. H. H. Swinnerton; D. *Zoology*—Dr S. W. Kemp, F.R.S.; E. *Geography*—Prof. T. Griffith Taylor; F. *Economics*—Mr R. F. Harrod; G. *Engineering*—Prof. R. V. Southwell, F.R.S.; H. *Anthropology*—Prof. V. Gordon Childe; J. *Psychology*—Dr R. H. Thouless; K. *Botany*—Prof. W. Stiles, F.R.S.; L. *Education*—Mr. John Sargent; M. *Agriculture*—Prof. R. G. Stapledon, C.B.E.

The Ananda Temple of Burma

What is likely to be the last contribution relating to Burma published by the Archaeological Survey of India has recently been released. It is a Monograph on the Ananda Temple at Pagan in Burma in the series of memoirs published by the Archaeological Survey of India on the ancient monuments of India and Burma. Pagan, it may be noted, is the most famous Buddhist centre in Burma and among the hundreds of temples at the place there is no one which can equal Ananda as a religious monument or as a storehouse of inscriptions and sculptures. The date assigned for the foundation of this temple is 1090 A.D. in the reign of King Kyanzittha whose zeal and piety led to the adoption of Budhist as the Burmese national faith.

Like the religion of the land which came from India, the architecture of this and other Burmese temples, too, bears the stamp of Indian genius and craftsmanship. Placed in the centre of a spacious court surrounded by brick enclosure walls pierced with large gateways at each cardinal point, the Ananda temple is a perfect specimen of architecture in grace and proportions. The cruciform plan, the four terraces receding behind each other crowned by a spire rising to a height of 172 feet from the base,—these are the characteristics of its architecture and are typical also of Burmese Buddhist architecture in general. For long the prototypes of this style were not found in India, but as a result of the excavations and discoveries made by the Archaeological Depart-

ment of the Government of India at Paharpur in Bengal and at Lauriya Nandangarh in Bihar, there is now ample evidence about the existence of this particular style in early Indian architecture from the earlier centuries of the Christian era to the 8th century A.D. after which it seems to have developed more in Burma, Java and Cambodia than in the land of its birth.

Internally the Ananda temple is massive with solid walls of enormous thickness. Colossal standing images of the Buddha are enshrined in recesses on each side of the central mass of brickwork. Another peculiar feature of the temple is the frieze of glazed terracotta plaques which are embedded in small panels in the piinth around the temple. These plaques illustrate the wellknown episode of the Buddha's conquering the forces of Mara and have short labels in Mon, the old language of Burma. Other incidents of the Buddha's life are depicted in stone reliefs arranged in niches in each of the terraces. Colossal standing Buddhas are enshrined on the four faces of the innermost solid wall and there are some stone images which are considered to depict King Kyanzittha, founder of the Ananda temple. The external effect of the Ananda is as imposing as its internal details are of absorbing interest, and makes it a most interesting monument in Burma. The large vestibules with their characteristic arched openings and pediments, casting deep shadows round the building, add greatly to its awe and grandeur, while the numerous subsidiary pagodas and sikhars (spires) ranged round the main spire give it a touch of lightness and grace which is the admiration of all visitors.

Mars an Arid Planet

Several hypotheses have been put forward to explain the curious marks on the planet Mars. They have been taken to be gigantic clitches or canals or even long stretches of plant growth and other vegetation. But these hypotheses are not without their difficulties, and the latest is in regard to the vegetation-theory on Mars. The Science Service writing in the columns of the *Scientific Monthly of* January 1938, says that, according to the observations made at the Mt Wilson Observatory of the Carnegie Institution of Washington, it has been found, from a study of the light spectrum of Mars, that there is hardly any water vapour in the atmosphere of the ruddy planet. It is also pointed out that an outside limit for water vapour in Mars' air would be about 5 per cent of that present in the earth's atmosphere. No growth of vegetation is possible in this little amount of water vapour contained in the air, unless it be cactus or some allied form that requires but little water to grow and would thrive with such supply of water as Mars can afford.

Cooler Region Animals larger than Warmer Region Ones

A very interesting theory has been propounded by Professor Dobzhansky in regard to the variation of size of the body and its component parts in cool and warm regions. It is a matter for common observation and it is also usually believed, though no scientific explanation was so long forthcoming, that animals in the cold climate are larger in size than their respective prototypes in the hot regions. Professor Dobzhansky, after long and careful observations and also a study of various specimens, both collected in the field and grown in the laboratory, has come to the conclusion that though as a general rule animals in the hot regions are larger in body size than their brethren in the cooler climate, they have smaller body appendages than the latter (tails, legs, ears etc). The Professor finds a possible physiological usefulness in these phenomena. "In cold countries short ears, legs and tails are an advantage, because they radiate less heat; in warm countries such economy is not so imperative. The larger body size, on the other hand, is correlated with a relatively smaller body surface--again effecting an energy economy." (*The Sci. Monthly.*)

Proposed Excavation in Frontier

It is reported in the daily press (*The Hindusthan Standard* of Feb. 1, 1938) that archaeological exploration expected to yield important results is shortly to be undertaken in the N. W. Frontier by Dr Simone Corbiau, a Belgian lady, who is now in India touring important ancient sites and the museums, with the assistance and cooperation of the Archaeological Survey of India. Dr Corbiau is expected to go to

the Frontier early in March, and begin surface exploration and trial digging with the officers of the Survey in the Frontier.

Two years ago when Lt. Col. (then Major) Gordon first brought to light the existence of certain types of early terracotta figurines in the North West Frontier province, Dr. Corbiau after a careful study of these remains particularly at Sar Dheri near Charsadda, came to the conclusion that they were of prehistoric origin. It is noteworthy that in the top layers of the Sar Dheri mounds, terracotta heads of Hellenistic type were found, while on the lower strata were discovered the particular terracotta figurines with which Dr Corbiau's investigations were associated. Stone sculptures and other relics bearing an unmistakable stamp of the Hellenistic art are found all over the Frontier Province and it is believed that discoveries like those made at Sar Dheri are possible in the lower strata of the numerons mounds found all over the Frontier. To the archaeologist these mounds with their possibilities are like an unread book, the mysteries of which when unravelled are likely at least partially to reveal the as yet unknown history of the period between the prehistoric Mohenjo-daro age and the historic Buddhist age in India.

The object of Dr. Corbian's exploration is to study the relics of the earliest ages still available on the Frontier and to assign to them dates and to ascertain in what relation they stand to the chalcolithic culture of the Indus valley on the one hand and to the European remains which are ascribed to the Nordic (Aryan) race on the other. Certain analogies have been discovered between these Indian relics and the Anatolian remains, which, it is believed, may on proper study, throw considerable light upon the Aryan problem. It is interesting to note in this connection that in spite of all that is being said, very little archaelogical discoveries have yet been made which have a bearing upon the problem of Aryan emigration in the remote ages. The only discovery yet made which probably is of some relevance is of some tablets discovered at Tel el Amarna in Egypt which are said to date back to 1400 B.C. and record the terms of a peace arranged between the Mittani race of Syria and the Hitities living in the regions of the Taurus mountain. In these tablets is found mention of names such as Indra, Mitra, Varuna, Nastya which the Aryans who came to India are known to have given to their Vedic Gods.

Unemployment and Government Service

The Government of India recently addressed a letter to all Provincial Governments for their opinion, in which they propose a suitable scheme for recruitment in future of all Government servants. What the Government contemplate is that there should be an examination to be taken at the age of seventeen, which would be of a competetive character, a definite number of passes or deplomas being offered each year. "Success in the examination would give no right to a Government appointment; the ages and conditions of admission to the different services would be regulated, as at present, according to the needs of each type. But failure in the examination would constitute a definite and final bar to Government service." In their letter the Government have anticipated some of the points of criticism which are sure to be levelled against this scheme, and have sought to answer them. The whole scheme or something like it, when launched on an all-India basis, as the Government propose in their letter to do, will involve the most careful planning. It is a bold scheme no doubt, and one beset with serious difficulties. Its effect on unemployment among the educated classes can, however, hardly be as great as the Government seem to believe. Even agreeing that those who are precluded by the test from entering the Government service in future get time and energy to look round for a suitable job in other directions, what are, we ask, the avenues open to them, in the present circumstances, unless, of course, there is a rapid industrial development and national reconstruction in the country within the next few years?

Move for Reorganization of Educational System in U. P.

The United Provinces Government have appointed two committees to examine and report on the reorganization of the present system of education. The first committee will consist of 10 members, which will be asked to examine the organization, control and curricula of the present primary and middle stages of education up to the end of class VII and to make recommendations to Government for reorganization and readjustment with special reference to (*a*) the extent and content of the primary and vernacular

middle courses including the number and kind of text books necessary and the extent to which handwork and crafts can be developed in primary and vernacular middle schools; (*b*) the hours of work in the schools; and (*c*) the control of vernacular education (*i*) by Government with reference to the reorganization of the Board of Vernacular Education, and (*ii*) by Local Boards with reference to the amendment of the District Boards Act and the Municipalities.

The second committee will consist of 11 members and will be requested to (*a*) survey the extent and content of Secondary and pre-University courses including the possibility of transfer of class XII to Universities and the utilizing of class XI for preparation for specified courses; (*b*) to make proposals regarding control and administration of Secondary Education with special reference to the working of the Intermediate Board; (*c*) to submit proposals in connection with the Wood-Abbott Report and to define the content of Secondary Education for boys and for girls; and (*d*) to consider what organization of schools, Anglo-Vernacular middle school, High Schools and Intermediate Colleges, would produce the best results.

Professor Charles Gravier

We learn with profound sorrow of the death of Charles Josheph Gravier on December 15, 1937, at his Paris residence. He was the Professor of Zoology (in the Department of Worms and Crustacea) in the National Museum of Natural History of Paris till his retirement from the chair in October, 1937.

He was born at Orléans (Loiret) on March 4, 1865, and graduated both in physical and natural sciences from the University of Paris. Although he got the degree of Docteur ès Sciences naturelles in 1896, his true scientific career did not begin till 1898 when he became the chief collaborator of the late Edmond Perrier, who was then occupant of the Chair of Malacology in the Museum, a chair associated with the name of Lamarck—a *clarum et Venerabile nomen* in the domain of biological sciences. The stimulating influence of this Master soon brought him to a different and almost a new field of work, *viz.*, Worms and Crustacea, subjects whose investigations were very little encouraged in France in those days.

It was the days of Lacaze-Duthiers and Edmond Perrier when the enterprise to start marine biological laboratories for collecting and examining marine fauna was just started. Such an enterprise made a stir in the young mind of Gravier. And in the following years (1904-1905) he left Rue Buffon for conducting scientific voyages to Somali Coast, Gulf of Aden, Saint Thomas Island (Gulf of Guinea) in quest of unknown or little-known marine fauna. Detailed reports of these expeditions were however subsequently published in the *Bulletin* of the Museum.

His works which were confined mostly to *Polychaeta*, *Madreporaria*, *Alcyonaria* and *Stomatopoda*, are however regarded to-day as of exceptionally rare merit. They soon earned for him not only the recognition, which he so richly deserved, from his fellow workers, both at home and abroad, but also a chair in Zoology (Department of Worms and Crustacea) specially created for him in the Museum in 1917. He was elected in 1922 a member of the Academy of Science (in the section of Anatomy and Zoology). His death will be regretted by almost every worker in these two important branches of Zoology for the development of which he consecrated three scores and twelve fruitful years of his valuable life.

Possibility of Production of Power Alcohol

The Government of Bombay have appointed an informal committee of experts to inquire into the possibilities of producing power alcohol from materials used for the manufacture of country liquor, with a view to utilizing it for industrial purposes. Mr. P. B. Advani, Director of Industries, is the chairman of the committe, which has already held two sittings. The appointment of this committee was discussed some time ago at a conference presided over by the Hon. Mr. L. M. Patil, Minister for Local Self-Government, at the Secretariat. The committee is considering the question with special reference to the use of power alcohol not only for motor vehicles but also for industries.

Science in Industry

Utilization of Molasses as Road-making Material

The Imperial Institute of Sugar Technology at Cawnpore have been for some time engaged in experiments for converting molasses into an insoluble resinous product suitable for use as road-surfacing material. The *Indian Trade Journal* publishes an account of the process in a note contributed by the Director of the Institute under the title " Results of Experiments on the utilization of molasses as roadmaking materials." The success of the experiments has been fairly achieved. The whole process of conversion is described below in the following extracts from the article.

The improved process of manufacturing the composition consists in carrying out the resinification of molasses with a mixture of coal tar and asphalt in the presence of acids such as sulphuric acid. The carbohydrates contained in molasses combined with the phenolic bodies contained in asphalt and coal tar to form a resinified compound perfectly insoluble in water, satisfying the following conditions: -

Perfectly liquid at the time of application.

After being spread on the road not melting in summer.

Not wearing away in heavy traffic.

Cheaper than other asphalt preparations in the market.

The success of the operation depends upon the preliminary removal of the last trace of moisture from molasses before mixing with other ingredients. Exhaust molasses are concentrated in an iron pan with constant stirring until the temperature rises to 135° C. with progressive thickening so that the molasses can be drawn into strings. Dilute sulphuric acid corresponding to 1 per cent of the weight of concentrated molasses, is added slowly and heated until the temperatrue rises further to 210°-230°C. A mixture of asphalt and coal tar is melted in a separate furnace fitted with dilute sulphuric acid. Molasses treated with sulphuric acid, as described, are then gradually incorporated in the acidified liquid asphalt and coal tar mixture, the stirrers running constantly. When the requisite proportion has been added, the heating is continued at atmospheric pressure till the test samples show absolute insolubility in water. The product is obtained in a pasty condition, easy to handle and suitable for application in stone chips. The solubility of the product is almost nil. The top surface of the molasses tarmacadam composition sometimes shows signs of peeling off at the surface after two or three months, unless a suitable seal coating material is applied, which should make the surface quite smooth. A good seal coating material is prepared by dissolving the molasses-asphalt-coaltar composition in the production of 1 lb. to 1 gallon of coal tar. The seal coating material is quite liquid and easy to apply to to the road surface.

The road composition and seal coating material have been protected by Indian Patent No. 24582.

The note then describes in detail how molasses tarmacadam should be applied in the building of roads, and in conclusion, gives details of costs, for example,

				As.
Cost of molasses 132 lbs. at 4/- per maund				6.41
Sulphuric acid 1.15 lbs. at - 1/ per lb.			..	1.15
Asphalt 13 lbs. at Rs. 160 per ton			..	11.30
Coal Tar at Rs. 1-14 per gallon, including container	..	..	..	7.50
Labour ..	..	..	..	5.40
		TOTAL	..	31.75

The above will produce 106.25 lbs. of the road composition.

Hence for the manufacture of 1 ton of the road composition the cost will be .. .. Rs. 45-12-0

(Note: The cost of asphalt is Rs. 160 per ton).

Figures for cost of constructing a road 20 ft. · 10½ ft. wide:

Stone chips, big and small, 632 cubic ft. at Rs. 20 per 100 cubic ft. .. Rs. 52-0-0

Indian Sugar Industry

Speaking on "The Sweet and Bitter Aspects of the Sugar Industry in India, at the Rotary Club of Calcutta on the 8th February last, Rotarian Wolff said that comparing the cane in India with that of Java one would immediately notice the big field open for improvements. The industry was however in steady progress and the speaker had noticed that South India was producing better cane than other parts of India. There had been vast improvements in the manufacturing process of sugar and efforts were noticeable to increase the efficiency of the factories. Under present conditions average extraction in Indian mills was 88 per cent against 94 per cent in Java. "Taking into account the present prices for sugar," the speaker said, "I have calculated that the 150 factories in India crushing about 12 million tons of cane waste 22 lakhs worth of sugar with every per cent they are not increasing their extraction over 88 per cent and in case they could reach the same average as Java which I consider absolutely possible, India would save 1-1/4 crores of rupees which otherwise are completely lost. This is certainly a very serious matter and not to be neglected by those who have to watch for the most economic exploitation of the natural wealth of this country."

While commending the Government for their willingness to further the industry, the speaker suggested that some provisions should be made to compel factory owners to pay special attention to the efficiency of their factories specially with regard to the quality of sugar, but mainly with regard to the best utilization of the cane. In this connection he pointed out that if a scheme could be introduced whereby the excise duty was paid per maund of cane crushed instead of on the quantity of manufactured sugar as at present obtained, it was obvious that the manufacturer has every interest to make the best use of his raw materials. He emphasized that there should be standardization of sugar qualities which would itself lead to the production of better types of canes fetching a fairly good price to the cultivator.

Proceeding he said that everything depended on the consumer. "If you refuse to buy dirt offered you as sugar," said he, "the manufacturers will have to manfacture first class qualities, and the more you consume, the cheaper the sugar will become."

Concluding, he referred to the conversion of molasses into power alcohol and regretted that the Government of India were reluctant to grant licenses to factories to produce power alcohol. This would not only make petrol cheaper but the sugar industry have a further source of income.

Coal Trade in India

Presiding over the sixth annual meeting of the Indian Coal Merchants' Association, held at Jharia on Feb. 6th, Mr. R. K. Mazumdar observed *inter alia* that a "feature of the industry (coal) which deserves serious consideration is that, tempted by the improved market, a number of small collieries have been recently opened, and, if production is not controlled in time, the same old question of over-production will again arise and the market will be soon adversely affected." He further observed that the condition of the coal trade was much better in 1937 than in many previous years. There were market fluctuations, no doubt, but, on the whole there was a brisk trade at a profitable rate throughout the year. The coal mrechants were not, however, so much benefited by the market. This was mainly due to lack of unity amongst themselves. By joint action the merchants could establish a better relationship with the collieries and eliminate many difficulties which arise out of sheer misunderstanding. Proceeding, Mr. Mazumdar said that they were given to understand that the world depression was now over, and that the coal trade had improved for that reason. But in reality it was quite evident that, owing to political disturbances all over the world, the iron industry had enormously developed and the coal market had improved on that account as a natural sequence. A real solution had yet to be found for maintaining a steady and healthy condition of the industry and the trade.

Education as Helpmate to Industry

"Education as Helpmate to Industry" contributed by Dr Nazir Ahmad, forms the subject of this month's article in our Science in Industry Section. India is gradually developing into an industrial nation and in view of the changes due to this, we have to mould ourselves accordingly. Dr Nazir Ahmed here deals with the question: How best should the system of education in this country be amended? And he seeks to answer it in the following pages.

Education as Helpmate to Industry

Nazir Ahmad
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In one of his books, George Borrow gives a vivid account of his meeting with an eccentric collector of curios, who, with incredible perseverence, had performed the difficult feat of learning the Chinese language, but who nevertheless could not read the time on the dial of an ordinary clock. For this almost hourly necessity he had to depend upon the assistance of others, and therefore, his education, though profound in the mysteries of Chinese syntax and grammar, was perfectly useless to him from the practical standpoint. We in India should take particular care to see that our systems of education do not resemble those of the old gentleman, that while putting undue emphasis upon the beauties of art or the mysteries of metaphysics, they do not fail to equip us with adequate weapons for forging our way in the intensely practical modern world. This caution is all the more necessary as there prevails in India an unfortunate tendency to glorify systems or institutions merely on account of their antiquity without paying any regard to their usefulness or value to the society.

The educational systems of India were devised long ago and modified occasionally with specific objects in view. It is not my intention to enter into an analysis of these objects, nor give a historical account of the development of the various educational systems in India. I should, on the other hand, content myself with making a few suggestions as to the type of subjects which, in view of the present day world forces and their reaction on India, deserve special attention in our universities.

India is generally looked upon as an agricultural country to the exclusion of any other conception regarding her. This attitude of mind is responsible for moulding her educational systems in a manner which, to my mind, is not entirely satisfactory. While it is true that agriculture is *at present* the principal industry of India, it is also true that no country can nowadays reach the zenith of her power by depending upon agriculture alone, and that for the fullest realization of her national resources industrial development is indispensable. Many countries in the West, including those which were hitherto regarded as being primarily agricultural like India, have recognized the truth of this statement and have embarked upon 4 5 year plans of rapid industrial development. In India the need for such a change of outlook is even greater, as owing to a large increase in population, the importation of foreign manufactured goods and the neglect of modern agricultural methods, the pressure on the land has increased to an alarming extent, bringing poverty, disease and ignorance in its wake. One of the most effective ways to combat these evils is to take away an appreciable fraction of the population from the field to the factories. Another reason why this step should be taken with the minimum loss of time is the growing danger of a series of such catastrophes as convulsed the whole word in 1914-18. In the event of another armageddon in Europe, while India can satisfy her needs in the matter of food stuffs, her supplies of scores of manufactured articles, including those of daily use and necessity, will either be severely restricted or completely stopped. Assuming, therefore, that the impact of world forces from abroad and a general awakening at home will turn the attention of our peoples to industrial enterprise, the question arises: Can our universities and technical institutions supply men *in sufficient numbers and with proper training* to help the industry to place itself on a sound and secure basis? As matters stand at present, the answer to this question can only be given in the negative. It is, therefore, necessary that in the readjustment of the existing departments or the institution of new ones (the latter process is not always easy owing to financial considerations) our universities should pay special attention to such subjects as form the bed-rock of industrial development. Among these subjects, those which have so far been sadly neglected are (1) ***industrial chemistry***, (2) ***chemical engineering***, (3) ***geology***, (4) ***metallurgy and assaying*** and (5) ***mining***. Until we develop a

study of these subjects in our universities and turn out a sufficient number of trained young men possessing both theoretical knowledge and experimental skill, we cannot hope to develop our national resources to their fullest extent and shall always remain in a state of industrial dependence upon others. It is true that the capitalists must come forward to invest money in industry, but the universities must also contribute their share by providing suitably trained men to carry on the work in an efficient manner.

Industrial development in any country is intimately connected with the availability of cheap power. One of the forms in which power can be most conveniently supplied to industry is electricity, which may be produced from coal, heavy oils or waterfall. Apart from serving as a handmaiden of industry, electricity has a thousand and one other applications in our daily life. In fact it so premeates our existence that just as we read in the history of the stone age, the bronze age, etc., the modern times will in all probability be known by the future historians as the electric age. As a result of it, new activities dealing with the manufacture of electrical goods for everyday use have sprung up in most Western countries. In India the use of electricity has so far been restricted to larger towns, but there is no doubt that as more and more of our power resources are tapped, electricity will spread to the smaller towns and villages. We have an example of it in the United Provinces where the construction of the grid system over the Gangetic Canals has brought electricity to the very doors of the cottages. The demand for the manufacture of bulbs, fans, small motors and dynamos, cooling plants, thrashing machines, ovens and geysers, radio sets, etc., is bound to increase, and the universities can materially help towards the development of this phase of our national life by instituting courses in *applied electricity* and *electrotechnics*.

I shall now turn from the industrial needs to another aspect of our national life which has great possibilities in the future. I refer to civil aviation. The Great War, which brought untold misery, waste and bitterness to the world, was responsible for a rapid development in the construction of aeroplanes and the art of flying. Since then the rate of progress in these allied branches of human activity has been even accelerated and there appears to be little doubt that except for the transport of heavy goods airways will be used more and more in the future. India with its vast distances is pre-eminently suited to travel and transport by air, and it is almost certain that within the next few decades great strides will be made in this direction. Here again our universities can render very great assistance by including such subjects as (1) *dynamics*, (2) *meteorology*, and (3) *aeronautics* in their courses of study and providing facilities for the *training of pilots*.

Besides providing for or encouraging higher instruction or research in the subjects which we have indicated above as deserving our special attention, the universities can render valuable service to industry in another way. They can institute diploma courses in several subjects which perhaps do not possess sufficient theoretical background or academic interest to be raised to the status of a degree course, but which, nevertheless, can form the nucleus of a flourishing trade and afford employment to a number of people. It must be remembered that in all countries besides heavy industries, a large number of people are employed in arts and crafts which secure them means of subsistence and promote the internal trade of the country. In the industrial expansion of Japan the small or village industries have played a very important part. The Indian universities can render real service by instituting diploma course in such subjects as Art Printing, Leather Curing and Manufacture, Essence and Perfume Manufacture, Fruit Canning, Preparation of Fruit Essences and Syrups, etc.

Time is now past when we should look upon education merely in the abstract or only as a means of imparting culture. The international competition and the struggle for existence have revolutionized our ideas. The educational resources of the country must be harnessed in the cause of its industrial expansion and development. Will the Indian universities veer round and adapt themselves to the needs of the modern times or will they have to be replaced by technical institutions?

C'est la question.

Research Notes

Investigations on the Rectification of Alternating Current by Crystals

Various theories have been put forward to explain the action of the crystal detectors. Eccles (*Proc. Phys. Soc.*, *25*, 1915) gave a complete theory based on thermo-electric action at the contact point of the crystal. Dowsett (*Wireless Telephony and Broadcasting*, *2*, 14-44) mentioned two other causes besides the thermo-electric cause for the phenomena of rectification in crystals, *viz.* (1) the electro-chemical nature of the elements comprising the crystal and (2) the crystal structure. James (*Phil. Mag.*, *49*, 1925) suggested an electrolytic theory. Schleede and Buggisch (*Phys. Zeits.*, *28*, 1927) maintained a theory based on arrangements of parts approximating a point and a plane.

It was Schottky (*Zeits. f. Phys.*, *14*, 1923) who first put forward an electronic theory of rectification. According to Schottky, the rectified current is a purely electronic flow, which takes place between two electrodes separated by a dielectric interlayer. Pelabon (*Comp. Rendus*, Feb. 25, 1929) in a similar way worked out a formula for the rectified current which seemed to agree with his experimental results. Similar theories have been worked out by Frenkel and Joffé (*Phys. Rev*, *39*, 1932) and Van Geel (*Zeits. f. Phys.*, *69*, 1931).

Ogawa's theory (*Phil. Mag.*, *6*, 1928) is based on the cold electron emission. According to him, the rectification is brought about by the difference of the electronic emissions from the two electrodes forming the contact.

Reglar (*Phys. Zeits.*, *29*, 1928) suggested that the rectification phenomenon could be traced to the piezo-electric effect.

R. de L. Krönig (*Nature*, March 2, 1929) showed in a general way that the crystal rectification could be due to asymmetrical binding of the ions into positions of equilibrium by restoring forces not symmetrical for equal and opposite displacements. Khastgir (*Ind. Jour. Physics*, *9*, Part 4 and *Nature*, *135*, Jan. 26, 1935) developed a theory based on the existence of an unbalanced electrostatic force on the crystal surface which can explain many observed facts about crystal rectification in the case of ionic crystals which do not show volume rectification.

Two different kinds of rectification have been pointed out by Khastgir and Das-Gupta (*Ind. Jour. Physics*, *9*, Part 3). One is always associated with point contacts and is called the contact-point rectification. The other kind the volume rectification which has been found to be independent of any point action— has been demonstrated in carborundum, silicon and zincite crystals. Recently Deaglio (*Atti R. Acad. delle Scienze Classe Fisica*, *70*) confirmed the existence of volume rectification in the different varieties of the carborundum crystal. It was Pierce (*Principles of Wireless Telegraphy*, 168, 1910) who must have first observed this volume rectification in carborundum. When a specimen of carborundum was platinized on two sides so as to make good conducting contact with both electrodes of the clamp, the currents were found to be different in the two opposite directions. An experimental study of the potential drop over the body of carborundum and a few other crystals by Chakravarty and Kastgir (*Zeits. f. Physik*, *195*, 1/2, 1937) has also shown volume rectification in carborundum.

The effect of heat, ultra-violet light and X-rays on contact point rectification was undertaken by Jackson (*Phil. Mag.*, May, 1928) and more fully by Khastgir and Das-Gupta (*Phil. Mag.*, March 1935). Sen (*Ind. Jour. Physics*, *9*, 1936) confirmed the results on the effect of heat and ultra-violet light. The effect of heat on the volume rectification in carborundum has also been studied recently by Chakravarty and Khastgir (*Phil. Mag.*, July, 1937). An interpretation of the experimental results has been given in the light of Wilson and Fowler's electron theory of semi-conductors.

It has been tentatively suggested by Khastgir (*Nature*, *139*, Jan. 2, 1937) that the uni-polar electrical conductivity which causes volume rectification in carborundum may be attributed to the asymmetry of the crystal structure. Others again have suggested that the cause of volume rectification is the non-homogeneity of the crystal.

S. R. Khastgir.

Behaviour of the Forbidden Oxygen Lines

For both normal and doubly ionized states of oxygen atom where the electronic configuration is $1s^2 2s^2 2p^4$ and $1s^2 2s^2 2p^2$ respectively the ground terms are $^3P_{0,1,2}$; $^1D_2$; $^1S_0$. Under all normal circumstances, electron transitions amongst these levels are not allowed, but it is well known that under special conditions such transitions do occur and investigators have observed emission lines due to these transitions for oxygen in laboratory, in earth's atmosphere and in celestial nebulae. The transition $^1D_2 - ^1S_0$ is referred to as "*auroral*" and the two lines due to the transition $^3P_{0,1,2} \rightleftarrows {}^1D_2$ as "*nebular*" in literat

E. U. Condon has given the theoretical values for the transition probability of these lines (*Astro. Journ.*, *79*, 217, 1934), where he has shown that the "*auroral*" line should be from one to two hundred times as strong as the strongest line in the "*nebular*" pair. This theoretical value is very nearly corroborated in the spectrum of aurora as well as in that of the night sky light under all normal circumstances. But the case is entirely different when auroral displays are illuminated by sunlight or when the light of the night sky comes from regions that still receive radiations from the sun. Under such conditions the ratio of the nebular to the auroral light attains a much higher value and, at times, even becomes greater than unity. In nebulae, on the other hand, it is always observed that the pair of nebular lines are stronger than the auroral one.

Though these facts go straight against the theoretical value of Condon for the ratio of these intensities calculated only on the basis of inherent probability of the emitter, still one has some justification for it when one finds that the statistical weight of atoms in *S*- and *D*-states may vary according to the physical conditions. But this argument falls through in the case of the lines of the nebular pair due to the transition $^3P_{0,1,2} \rightleftarrows {}^1D_2$. Here the transition starts from a common single metastable state $^1D_2$ and as such the ratio of intensity should depend on the inherent transition probability of the ^3P-states regardless of the physical condition of the emitter. So that whatever the actual value of the ratio might be it should persist everywhere, whether in laboratory, nebulae or novae.

For some time past it has been reported by various investigators that the intensity ratio in the nebular pair of lines in the spectrum of novae is not found to be constant in every case. But the method of observation contained so many points against it and the theoretical reasons were so strongly against such observations that they were not accepted as very reliable. N. T. Bobrovnikoff and J. M. MacQueen took up this subject for investigation taking all the possible precautions to arrive at some definite and at the same time reliable conclusion for the relative intensities of the nebular pair of lines and reported their work in the *Astrophysical Journal* (*86*, 446, 1937). These investigators measured the relative intensities of the nebular pair of O_1 from photometric tracings of eleven plates of Nova Herculis 1934 photographed at different times from Jan. 5, 1936 to March 30, 1936 and showed that the intensity ratio I_{6300}/I_{6363} varies from a maximum value of 3.48 to a minimum of 1.46, the mean value of all the observations being 2.74 with the probable error as 0.14. The required theoretical ratio of the two intensities as given by Condon is 3. Thus they conclude with perfect definiteness that as far as their plates are concerned the fact of variation is beyond doubt.

The problem is of such interest from the theoretical viewpoint that it should attract attention of other investigators theoretical as well as experimental.

S. C. Deb.

RESEARCH NOTES

Preparation of Weighable Quantities of Isotope 87 of Strontium as Product of Transformation of Rubidium—from a Mica of Canada

In order to elucidate the question of the mass of the radioactive isotope of Rb, Hahn, Strassmann and Walling (*Naturwiss*, *25*, 189, 1937) have treated a mineral of mica from the Great Beak lake containing 2-3% Rb.

They have extracted 250 mg. of $SrCO_3$, which have been analysed by the Mass spectograph. It is found that the principal constituent (99%) of the product is 87 Sr while the ordinary principal isotope 88 of Sr is present only to the extent of few parts per thousand. One has thus the direct proof that the active isotope of Rb is 87 Rb; which is in accord with the rule of Muttauch (*Z. Physik.*, *37*, 361, 1934) according to which 2 stable isobars of odd atomic weight cannot exist; one of the isobars 87 Rb--87 Sr must be unstable.

P. B. S.

Artificial Radioactivity in Therapeutics

The neutrons obtained by the bombardment of Be with γ-rays of Ra and slowed down in paraffin have been utilized by Lafay and Lafay (*C.*, *R.*, *204*, 1593, 1937) for activating different salts of As and I in order to see their therapeutic applications.

It has been found that the intervenous injections of (Rd -Na)I gave in the treatment of rheumatism results as good as that obtained with MsTh or Rn with the advantage that the blood formula is not sensibly altered in the present case.

Besides Rd -I has been utilized to bring in direct contact the cancerous cells with the β-ray it emits.

P. B. S.

Counteraction of Cereal-ricket by Fat

Ricket is produced in young puppies when large amounts of cereals are added to diets relatively poor in calcium and vitamin D. The greater the proportion of cereals in the diet, the greater is the degree of rickets produced. Some cereals cause worse rickets than others and these differences bear no relation to the calcium or phosphorus content of the cereals. From the results of the researches of several workers there seems some reason to believe that the rachitogenic action of cereals, in diets which are relatively, although not absolutely, deficient in calcium and vitamin D, is due to the relatively high proportion of phytin in cereals.

Boyd and others found that moderate amounts of fat (10%) increase the intestinal absorption of Ca and P, probably by making an acid reaction in the intestine so that Ca soaps are formed, which are well utilized. Absorption of Ca in children was optimal if the food contained a proportion of 0.04—0.08g Ca to 1g fat. The rachitogenic action of cereal diets appears to be due to interference with the absorption of Ca from the intestine.

Since it is known that fats have a great influence on the intestinal absorption of Ca it seemed probable that the addition of fat to such cereal diets would counteract their rachitogenic tendencies by creating more favourable conditions in the intestine for Ca absorption.

E. J. McDougall (*Biochem. J.*, *32*, 194, 1938) carried out rat feeding experiments, using the high cereal diets to produce rickets in young rats. Fat was added to some of the diets and a calorically equivalent amount of starch to others, to test whether the addition of fat alone would prevent the rickets produced by these cereal diets. The quantity of fat added was about 11% of the total weight of food, a proportion which is quite usual in human diets. Of the three fats tested, lard, olive oil, and cocoanut oil, lard gave the best protection against rickets and also the best growth curves; olive oil was rather less favourable to growth and less certain in its prevention of rickets. Cocoanut oil gave very incomplete protection against rickets but it also interfered with the appetite and growth of the animals, so that its purely protective action cannot be judged from these experiments.

A normal amount of fat in the diet seems to be important for the solubility in the intestine (and hence for the absorption and utilization) of calcium and phosphorus.

H. N. B.

University and Academy News

Royal Asiatic Society of Bengal

The Annual Meeting of the Royal Asiatic Society of Bengal was held on Monday, the 7th February 1938 at 5-30 p.m. The following office bearers were elected for the year 1938.

President.—Sir David Ezra.

Vice-Presidents.—Dr A. M. Heron, Lt.-Col. N. Barwell, Brevet-Col. R. N. Chopra, The Hon'ble Mr. Justice John Lort-Williams.

General Secretary. Mr. Johan Van Manen.

Treasurer.—Mr. Percy Brown.

Philological Secretary.—Dr S. K. Chatterji.

Joint Philological Secretary.—Shamsu'l 'Ulama Mawlavi M. Hidayat Hosain.

Natural History Secretaries.—Biology:—Dr Baini Prashad, Physical Science:—Prof. J. N. Mukherjee.

Anthropological Secretary.—Dr. B. S. Guha.

Medical Secretary.—Rai Sir Upendra Nath Brahmachari Bahadur.

Library Secretary.—M. Mahfuzul Haq, Esq.

Other Members of Council.—Mr. N. G. Majumdar, Mr. K. C. Mahindra, Mr. W. D. West, Sir George Campbell, Capt. C. L. Pasricha, Dr Kalipada Biswas.

An ordinary Monthly Meeting of the Royal Asiatic Society of Bengal was held on Monday, the 7th February, 1938, immediately after the termination of the annual meeting. The following candidates were balloted for as ordinary members.

(i) Pramatha Kumar Chakravarty (Calcutta).

(2) M. D. Chatterjee (Agra).

(3) Lalita Prasad Sukul (Calcutta).

The Indian Chemical Society

The Fourteenth Annual General Meeting of the Indian Chemical Society was held on Wednesday, the 5th January, 1938, at 3 p.m. in the Chemistry Section room of the Indian Science Congress at Calcutta with Professor J. C. Ghosh, President, in the chair. The following office bearers were elected:

Vice-Pesidents.—Pr B. Dey and Prof. J. N. Mukherjee

Hony. Secretary.—Prof. B. C. Guha

Hony. Treasurer.- Prof. P. Neogi;

Hony. Auditors.—Mr P. C. Nandi and Mr. T. K. Roychoudhury.

Ordinary Members of the Council.—Prof. P. Ray, Dr M. S. Patel, Dr P. C. Guha, and Dr K. L. Moudgill.

The Hony. Secretary's report and the Hony. Treasurer's statement of accounts were read and adopted.

The Council's proposals regarding the publication of the Industrial and News Edition of the Society's Journal under the joint auspices of the Indian Chemical Society and the Institution of Chemists (India) were read by the Secretary and adopted.

Professor J. C. Ghosh read his presidential address on "Physico-chemical investigations of Vitamin C."

Calcutta Mathematical Society

The Annual General Meeting of the Calcutta Mathematical Society was held in the Society's room on Sunday, the 30th January, 1938, at 4-30 p.m.

The Annual and the Auditor's reports for the year 1937 were read and adopted.

The following Office-bearers and other Members of the Council for the year 1938 were elected:

President.—Principal B. M. Sen, (Calcutta).

Vice-Presidents.—The Hon'ble Sir S. M. Sulaiman, (Allahabad); Professor C. V. Hanumanta Rao, (Lahore); Dr. N. N. Sen, (Calcutta); Professor F. W. Levi, (Calcutta).

Treasurer.—Mr. N. C. Roy, (Calcutta).

Secretary.—Mr. S. K. Chakravarty, (Calcutta).

Other Members of the Council.—Professor N. R. Sen, (Calcutta); Professor A. C. Banerjee, (Allahabad); Dr. M. R. Siddique, (Hyderabad); Professor N. M. Basu, (Dacca); Dr. C. N. Srinivasienger (Bangalore); Dr. J. Ghosh, (Calcutta); Dr. R. N. Sen, (Calcutta); Dr. S. C. Dhar, (Nagpur); Mr. Satis Chandra Ghosh, (Calcutta); Mr. H. P. Bannerjee, (Calcutta); Dr. V. V. Narliker, (Benares); Mr. Ramendramohan Majumder, (Calcutta).

The following papers were read:—

(i) D. N. Sen and V. Rangachariar:—On the Zeros of Generalized Jacobi Polynomials.

(ii) M. Roy:—Motion of two Infinite circular cylinders in rotating fluids.

(iii) N. Rama Rao:—Some congruences of modulus *m*.

Indian Physical Society

The Fourth Annual Meeting of the Indian Physical Society was held at 3 p.m., on the 5th January, 1938, in the physics lecture room, Baker Laboratories, Presidency College, Calcutta, with the President, Prof. M. N. Saha, in the chair.

A resolution expressing condolence at the sad demise of Lord Rutherford of Nelson and Sir Jagadis Chandra Bose was moved from the chair and passed.

After the President's introductory remarks, Prof. Sir Arthur Eddington delivered an address on "Scattering of protons by protons." Prof. W. Bothe of Heidelberg, then read a paper on Cosmic-ray showers.

The following were elected office-bearers of the Society for the current year.

President.—Dr. S. K. Banerji, (Poona).

Vice-Presidents.—Prof. D. M. Bose, (Calcutta); Prof. G. R. Paranjpe, (Bombay); Prof. M. N. Saha, (Allahabad); Prof. H. P. Waran, (Madras).

Secretary.—Prof. S. K. Mitra, (Calcutta).

Treasurer.—Prof. P. N. Ghosh, (Calcutta).

Members of the Council.—Mr. S. K. Acharya, (Calcutta); Prof. A. C. Banerjee, (Allahabad); Prof. S. N. Bose, (Dacca); Dr. B. N. Chuckerbutty, (Calcutta); Dr. P. K. Kichlu, (Lahore); Dr. D. S. Kothari, (Delhi); Prof. K. Prasad, (Patna); Dr. K. R. Rao, (Waltair); Prof. N. C. Ray, (Calcutta); Principal B. M. Sen, (Calcutta); Prof. N. R. Sen, (Calcutta); and Prof. M. R. Siddiqui, Hyderabad (Deccan).

Botanical Society of Bengal

The Sixth Ordinary General Meeting of the above Society was held on Wednesday, the 2nd February 1938 at 5 p.m. in the Botanical Laboratory, Calcutta University, 35, Ballygunge Circular Road, Calcutta.

The following paper was read:—

S. M. Sircar—"Nitrogen metabolism in relation to respiration of potato tubers"

Letters to the Editor

[The Editor is not responsible for the views expressed in the Letters.]

Absorption Spectra of $CoCl_2$ Vapour

In the ions belonging to the first transition group of elements, the $3d$ electrons are responsible for the magnetic properties as well as the colour shown by them. But both in crystals and solutions containing ions of this group the latter do not behave as free ions being subjected to an inhomogeneous crystalline electric field, which remarkably modifies their optical and magnetic properties. In the vapour state however the crystalline field would be absent and investigations of the magnetic and optical properties of these salts in the state of vapour should yield interesting results.

The absorption spectra of $CoCl_2$ vapour have been investigated at temperatures up to 1000° C. Anhydrous $CoCl_2$ prepared in the laboratory, was heated in a silica tube placed in a horizontal electric furnace and a column of vapour 30 c.m. long was obtained. It is found in standard treatises on chemistry that anhydrous $CoCl_2$ melts at 724°—735° C, at 800° C the vapour pressure is 91 m.m. and at 1010° C it is 522 mm. The silica tube was closed at both ends by plane quartz windows and connected by means of a side tube to a Cenco pump. When the furnace was maintained at 800° C, a number of absorption lines appeared in the red region and the lines were most prominent when the vapour was maintained at a reduced pressure (10-20 c.m. of Hg.). The position and nature of these lines are given in the table below.

TABLE I.

1.	6691,7 A.U.	..	Strong, sharp.
2.	6726,3 „	..	Very weak, sharp.
3.	6767,3 „	..	Strong, sharp.
4.	6798,3 „	..	Weak, sharp.
5.	6850,4 „	..	Strong, diffuse.
6.	6892,5 „	..	Strong, diffuse.

The width of the sharp absorption lines are comparable to that of the strong emission lines of neon.

In addition to the above lines a number of band heads degraded towards the red appeared in the blue and violet region. At a higher temperature (1000°C) and reduced pressure the bands were more prominent. The position of the band heads are given below.

TABLE II.

4186,4 A.U.	4410 A.U.
4210,5 „	4431,3 „
4256,9 „	4493,7 „
4281,1 „	4516,3 „
4330,9 „	4842,8 „
4351,9 „	4879,1 „

Mr. P. C. Mukherji, working in this laboratory, has observed bands in the same position in the absorption spectra of some rare earth halide vapours at high temperatures and these bands have been found to agree with some absorption bands of chlorine, observed by him for the first time, at very high temperature and reduced pressure.[1]

The absorption bands given in table II must then be attributed to the halogen molecule which is formed due to partial dissociation of $CoCl_2$ vapour at high temperature. Similar absorption bands have also been observed by the author with $CrCl_3$ vapour at very high temperatures (1400°C.). Saha and Deb[2] have also recorded a number of bands in the absorption spectra of $CrCl_3$ vapour in the blue and violet region, which they have ascribed to spin-transition in the Cr^{+++} ion due to light absorption by the $CrCl_3$ molecule. The bands given in Table II however agree in position with the bands recorded by Saha and Deb and from the evidence put forward, it seems probable that these bands are due to light absorption by chlorine molecules having an excited ground state. The sharp lines in the red region are however characteristic of $CoCl_2$ and must be attributed to some transition in the Co^{++} ion.

Further investigations are proceeding and the details will be published elsewhere.

Palit Laboratory of Physics,
92, Upper Circular Road,
Calcutta.
17-2-38.

S. Datta.

[1] To be published shortly.

[2] Saha and Deb. *Bul. Acad. Sci.*, U.P. *1*, 1, 1931-32.

A New Method for the Preparation of Plastics from Fixed Glycerides

Oils have been converted into products resembling lubricating greases, waxes and resins. By a further modification of the process, the same materials have been transformed into a powder with thermo-plastic and thermo-hardening properties. The conversion of fixed glycerides of this type into the products enumerated above, is an entirely new observation which has been made for the first time in these laboratories. The process depends upon three factors:—(1) presence of catalysts, (2) definite temperature, and (3) definite pressure. The nature of the final product—soft, hard and resinous, is determined by a variation in these three factors. The possibilities of this process from an industrial standpoint are very great, as our country is extremely rich in oils of all types and is at present time entirely dependent upon foreign supplies for the synthetic plastics, resins and lubricating greases of a superior quality. All

the ingredients are found in abundant quantities in India and no imported raw material is necessary for the process.

Department of Applied Chemistry, M. Goswami.
Calcutta University.
3-2-38.

Destruction of various Toxins by Digestion with Proteolytic Enzymes

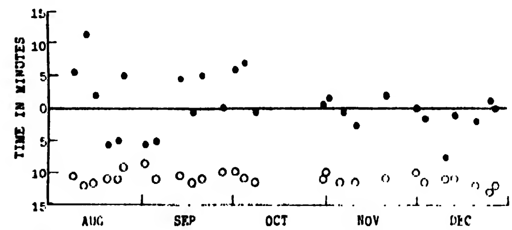
In the course of an investigation on the digestibility of toxins like those of diphtheria, tetanus and staphylo-coccus by different proteases it has been observed that while one M. L. D. of diphtheria toxin and two units (dermo-necrotic doses) of staphylo-coccus toxin are digested by 10 mg. of trypsin between *p*H 7—9 at 40°C within 45 minutes, one M. L. D. of tetanus toxin is, however, not destroyed under similar conditions. Even when the amount of enzyme used was increased to three or four times that used in the case of diphtheria or staphylo-coccus toxin the tetanus toxin was not destroyed. This seems to indicate that the proteins of tetanus toxin are somewhat different from those of diphtheria and staphylo-coccus toxins. When, however, the tetanus toxin is first digested with papain at a *p*H-4.6 for 45 minutes at 40°C and then digested with trypsin at 40°C for 45 minutes its toxicity is destroyed. Further work is in progress.

The Bengal Immunity Narendra Nath Ray.
Research Laboratory,
Barnagore.
8-2-38.

The Ozonosphere and the Early Morning Increase of the E-Layer Ionization of the Ionosphere

Since the ultra-violet radiation of the sun is mainly responsible for the maintenance of ionization in the upper atmosphere it is to be expected that the hours of sunrise in the E- and F-regions of the Ionosphere would show close correspondence with the hours of early morning increase of ionization—if any—in these regions. Observations in this connection were started here last July by Mr. S. P. Ghosh at my suggestion. A preliminary note on the significance of certain interesting results with regard to the E-region is given here. The F-layer increase phenomenon is complicated by several extraneous factors and a longer series of observations is needed for their proper interpretation.

The observational data are plotted in the Fig. The zero horizontal line represents the hour of sunrise in the E-region by the sun's rays grazing a surface 35 Km. above the surface of the earth. This line is also used as the line of reference. The dots represent the hours at which the ionization of the E-region begins to increase in the early morning; the circles represent the hours of sunrise in this region by the sun's rays grazing the surface of the earth. (The erratic variation of this latter is due to the irregular day-to-day variation of the E-layer height at the time of observation). It will be seen that the hours of increase (the dots) are grouped on either side of the zero horizontal line, *i.e.*, the time of increase of ionization in the E-layer agrees in average with the time of sunrise in the same region by the sun's rays passing 35 Km. above the surface of the earth. The sunrise grazing the surface of the earth (the circles) occurs on the average 10 minutes before the E-layer ionization begins to increase. The explanation of this becomes obvious if we remember that the top of the Ozonosphere is at a height of about 35 Km. and that the solar radiation, in order to produce the ionization, must pass above the Ozonosphere so as not to have its shorter wave-lengths absorbed by Ozone. The dispersion of the dots about the zero line is due to the irregular daily variation of the height and the content of the Ozone layer. In fact, the variation of the hour of the morning



increase of the E-ionization may be used as an index of the variation of the Ozone in the upper atmosphere. Unfortunately no data are available of the upper air Ozone content in India and so, it has not been possible to study quantitatively the correlation between the two.

There are, however, certain other points regarding the early morning increase of the E-ionization, the explanation of which is not quite as obvious as that given above for the increase occurring 10 minutes after the sunrise.

It is to be noted that the sun's rays, in order to reach the point of the E-layer under observation, had already had to pass through the E-layer at another point above the surface of the earth separated by a distance of an arc of about 16½ degrees. The sun's rays after ionizing this remoter region of the E-layer had penetrated into denser region of the atmosphere down to a level of 35 Km. and then passed through a region of decreasing density to finally emerge at the point of the E-layer under observation and increase the ionization there.

The fact that the solar rays when passing obliquely through the atmosphere is able to cause increase of ionization only at a certain definite height of the atmosphere (the E-layer height) at two different places shows that the atmospheric constituents at such heights must possess certain characteristic properties which are not possessed by the constituents at the lower levels and which make them easily amenable to ionization. Now spectroscopic study of absorption by O_2 shows that the only wavelengths in the ultra-violet longer than 1200 Å which can survive absorption after passage through the length of the oblique path under consideration (0.52 Km. of O_2 and 1.95 Km. of N_2 at N.T.P.)[1] are those in the region of 2000 Å. The ionizing wavelengths for photo-ionization of O_2 and N_2 being 747.8 and 660.9 Å respectively,[2] the wavelengths near 2000 Å are not capable of ionizing normal N_2 or O_2. These wavelengths may, however, cause ionization if N_2 and O_2 are already in the excited states. Now, the existence of excited N_2 molecules in the upper atmosphere in the *A*-, *B*-, and C-states (6.2, 7.3 and 10.9 volt) is established by the observation on the light of the night sky.[3] Transitions from these to lower levels give Vegard-Kaplan $A \longrightarrow X$, the first positive $B \longrightarrow A$ and the second

positive $C \longrightarrow B$ bands.[2,3] It is highly probable that the fourth positive band system $D \longrightarrow B$ is also emitted by the night sky but, as its wavelengths lie in the ultraviolet, it is cut off by the Ozone layer and is not observable. The *D*-state of N_2 corresponds to 12.8 volt and the absorption of radiation of wavelengths near 2000 Å by such excited molecules will produce ionization. Similar considerations applied to excited O_2 molecules—which are undoubtedly present in the E-region, but radiations from which, being in the ultraviolet, cannot unfortunately be observed—show that such excited O_2 molecules can also be ionized by the absorption of radiation near 2000 Å.

Wavelengths below 1200 Å which can directly photo-ionize normal N_2 and O_2 (660.9 Å and 747.8 Å) are, of course, also present in the solar radiation. Such radiations, however, when passing obliquely through the atmosphere cannot be expected to produce ionization at two different places at the same height (region of same atmospheric density). It is well known that solar radiation entering into regions of increasing density in the earth's atmosphere can produce maximum of ionization one for each constituent gas of the atmosphere only at one particular level of a definite density depending upon the ionization potential of the constituent gas. The ionizing wavelengths are completely absorbed near this level and the rays penetrating into denser regions cannot produce a fresh layer of maximum ionization.[5] If the optimum density for maximum ionization is greater than that obtaining at the lowest level reached by the rays (35 Km. in the present case when the rays are passing obliquely), then the rays cannot produce such a layer either before or after they have crossed this level.

The above view of photo-ionization of excited molecules also explains the mechanism of the auroral flash in the light of the night sky observed by Slipher when the "last and the first traces of the sunlight touch the high atmosphere".[6] Slipher's observations were presumably made when the upper atmosphere was illuminated by the sun's rays passing upwards obliquely from the bottom. Under such condition, as shown above, the oblique rays are deprived of the ionizing wavelengths less than 1200 Å and the flash must be due to the photo-ionization of the excited molecules by wavelengths near 2000 Å.

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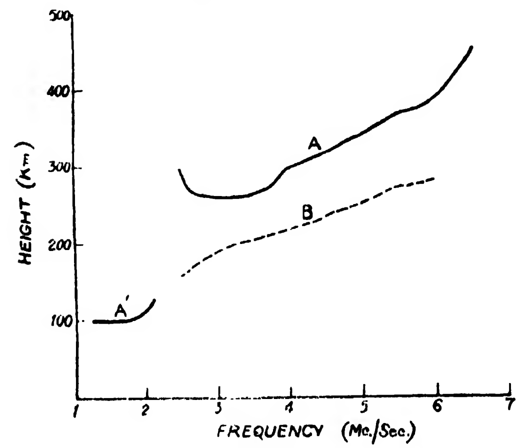
[1] Mitra and Rakshit, Paper No. 43, *Math and Phys. Section*, Indian Science Congress, 1938.
[2] Saha, *Proc. Nat. Inst. Sc. Ind.*, *1*, 226, 1935. Saha, *Proc. Roy. Soc.* A., *160*, 155, 1937.
[3] Dejardin, *Rev. Mod. Phys.*, *8*, 1, 1938.
[4] Pannekoek, *Proc. Amst. Acad.*, *29*, 1165, 1926.
[5] Chapman, *Proc. Phys. Soc.*, *43*, 26 and 483, 1931.
[6] Slipher, *Mon. Not. Roy. Ast. Soc.*, 93, 665, 1933.

Measurement of the true Height of the F-Layer

It is well known that the equivalent heights of the ionospheric layers as obtained by the Breit and Tuve's group retardation method are greater than their true heights. The difference between the two is small when the gradient of ionization is sharp, but it may be considerable when the gradient is low. It is of great importance to be able to make an estimate of the true height from observations on the apparent height. A method of approximately doing this has recently been described by Murray and Hoag.[1] In the present note the results of the measurement, carried out after the above authors, on the true height of the F-layer at Calcutta (Lat. 22° 32′ 48″ N, Long. 88° 21′ 24″ E) in the early hours of an autumn morning in 1937 are described.

The difference between the true and the equivalent heights is due to the wave travelling through the ionized regions with reduced



group velocity. For convenience of calculation these regions may be grouped as follows: (a) The region of maximum ionization of the E-layer, (b) the region between the top of (a) and the F-layer, which may possibly be ionized and (c) the F-region and the part of the F-region immediately below the region of maximum ionization. In our calculations it has been assumed that the region between the E and the F layers region (b)—is devoid of ionization. This is justified because our observations were made in the early morning when, on account of the absence of the ionizing radiations throughout the dark hours of the night, any ionization in this part is likely to disappear by the rapid recombination of the ions and the electrons. The thickness of this region has been taken as 50 Km. The contributions to the virtual height of the F-region due to the regions (a) and (c) are calculated after Murray and Hoag[2] with the help of the $P'-f$ curves of the E- and the F-regions (curves A′ and A in the figure). Curve B giving the actual heights reached by the waves is obtained from these. It will be seen that the true height is on an average about 80 Km. less than the virtual height. Similar calculations have also been made for other nights. Results with fuller details will be published in a subsequent paper.

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[1] Murray and Hoag, *Phys. Rev.*, *51*, 333, 1937.
[2] *Ibid*- p. 779.

Vitamin C in the Juice of the ripe Palmyra Fruit

The use of the juice of the ripe palmyra fruit (Bengali *Tal*) is very common in our rural areas. Concentrated with milk and molasses, the juice forms a nice delicacy. It is of interest to find out the vitamin C content of this stuff. The amount of invert sugars as well as the total sugar content of the juice has also been determined. Incidentally the vitamin C and sugar contents of the seed-vessel or follicle of the germinated palmyra-stone have been estimated. The vitamin C content in the latter case has been found to be greater than that found in the follicle of the cocoanut.[1] The ascorbic acid has been estimated by the well-known titration method of Harris and Ray[2] as modified by Ghosh and Guha[3] and Guha and Ghosh.[4] The usual method of reduction of the alkaline copper sulphate has been employed in the estimation of sugar.

The outer coarse covering of the ripe palmyra fruit is peeled off and the pulp is pressed to yield the thick syrupy yellow coloured juice. 10G. of the juice are weighed out in a mortar to which 2.5 c.c. of trichlor acetic acid solution (20%) are added. The whole is then tritrated with a few c.c. of distilled water and centrifuged. The centrifugate is made up to 100 c.c. and titrated against 2:6-dichloro-phenol-indophenol. To find out the effect of heat, a portion of the juice was maintained at its boiling point for half an hour, cooled and the ascorbic acid was determined in the usual manner. The follicle was also similarly treated. The invert sugar present in the juice was estimated directly by means of the Benedict's solution and the total sugar was found out by hydrolysing the juice with H_2SO_4 and then estimating sugar in the usual way. Dry weights of each of the samples were carefully determined and the ascorbic acid in mg. per g. of the dry weight was calculated. The sugar content is also given in the dry weight basis.

	Ascorbic acid in mg. per 1 g.	Ascorbic acid in mg. per 1 g. (boiling for ½ hour.)	% of simple sugar.	% of total sugar.
Palmyra fruit Lot I	1.745	1.163	2.04	5.18
Do. (Black variety) Lot II	0.639	0.254	2.29	4.69
Average ..	1.192	0.708	2.16	4.93
Palmyra fruit (Red variety) Lot I ..	1.844	1.441	2.57	4.21
Do. „ II ..	1.314	0.952	2.38	5.00
Average ..	1.579	1.196	2.48	4.60
Follicle of the germinated Palm stone Lot I ..	0.130	....	1.95	19.50
Do. „ II ..	0.217	....	2.41	17.50
Average ..	0.173	....	2.18	18.50

It is evident from the table that the red variety contains more ascorbic acid and more simple sugars than the black variety. As the follicle is always eaten raw, the action of heat on the stuff has not been observed. The total sugar content of the follicle offers a very interesting point.

We acknowledge our grateful thanks to the authorities of the firm.

Biochemical Laboratory, H. G. Biswas.
Bengal Chemical & Pharmaceutical Works Ltd. K. L. Das.
Calcutta.
27-1-38.

[1] Biswas and Ghosh, *Science and Culture*, *1*, 518, 1935.
[2] Harris and Ray, *Biochem. J.*, *27*, 303, 1933.
[3] Ghosh and Guha, *J. Indian Chem. Soc.*, *12*, 30, 1935.
[4] Guha and Ghosh, *Current Sci.*, *2*, 390, 1935.

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Silver Jubilee Session and Future of the Indian Science Congress Association

THE twentyfifth or the Silver Jubilee Session of the Indian Science Congress Association was celebrated at Calcutta from January 3rd to 9th, 1938, as a joint meeting of the Indian organization and the British Association for the Advancement of Science. This session was a great success in every way, and will stand out as a landmark in the history of the Association.

A brilliant galaxy of distinguished visitors from overseas, consisting of a representative contingent of the British Association and scientists from various European countries and America, took part in the deliberations of the various sections and helped to make the Jubilee Session the most important meeting in the history of the Association.

In other respects also the session was remarkable. The membership of the Congress rose to its highest peak some 1500 full members were enrolled in addition to several hundreds of sessional student members. The number of scientific papers contributed to different sections was the largest of any previous session: 875 papers are included in Part II (Abstracts) of the *Proceedings* of the session, which has already been issued; 22 discussions were organized in various sections in addition to 10 joint discussions in which members of more than one section took part.

To commemorate the Jubilee Session, special publications dealing with the history of the Indian Science Congress Association, ancient India's contributions to Science, Field Sciences of India and the Progress of Science in India during the past twentyfive years were arranged for publication by the Executive Committee of the Association. An attractive volume dealing with the Field Sciences of India was issued in November 1937, and a detailed review of the progress in various sciences during the past 25 years is, we are informed, almost ready, while the other two will be published at a later date.

In addition to some general lectures, 8 popular evening lectures were delivered, all of them by outstanding authorities, on highly interesting scientific subjects. The very large attendances at these lectures amply testified to the interest shown in scientific matters not only by the delegates attending the Indian Science Congress, but also by the general public.

The great success of the Jubilee Session is to be attributed to the efforts of the General Secretaries, Prof. J. N. Mukherjee and Mr W. D. West, who had to bear the very heavy barden of organizing the session. The parent body of the Congress, the Royal Asiatic Society of Bengal, also rendered valuable services in this connection. The

arrangement of the programmes for the tours of the overseas visitors in different parts of India involved a great deal of work, and the Congress is indebted for great help in this respect to the Government of India, the Government of Bengal, the authorities of the Hyderabad and Mysore States, and of the Universities of Hyderabad, Benares, and Calcutta. The success of the arrangements for the session was due in no small measure to the Local Committee under the presidency of Mr Syamaprasad Mookerjee, the Vice-Chancellor of the Calcutta University, and the two Secretaries, Principal B. M. Sen and Prof. S. K. Mitra; to all of them the Association and the Indian scientists owe a debt of gratitude.

The session was opened by the Patron of the Indian Science Congress Association, His Excellency the Viceroy. In a memorable speech His Excellency remarked that the Indian Science Congress, founded in 1914 with a view to encourage scientific research and publish the results achieved, to provide opportunities for personal intercourse and scientific companionship, and to promote public interest in science, had magnificently fulfilled all these aims, and as a result scientific work in India carried out during the past twentyfive years has gained international recognition. His Excellency stressed the relationships of science to social uplift and of its opportunities for service in the cause of the advancement of the country. The main financial burden for scientific research in the country, His Excellency pointed out, rests at present on the Government, either directly or indirectly, and more generous public support is urgently needed to supplement the work of the Central and Provincial Governments in this connection.

Sir James Jeans, who had been elected as the President of the joint session after the sudden death of Lord Rutherford of Nelson, read a short inaugural address followed by excerpts from the very inspiring address which the late Lord Rutherford had prepared for the occasion (*Vide Science and Culture*, 3, pp. 358-74). In his address Lord Rutherford, in addition to dealing with earlier research work carried out by various official scientific services and other agencies, briefly referred to the important contributions made by Indian workers since the Indian Science Congress was founded and the very important part played by Indian universities in encouraging and fostering scientific research. He also stressed the importance of improving the available organizations in the Indian universities, as they will hereafter have to play a more and more important part in providing the necessary staffs for teaching, for personnel of the scientific departments and services, and for industrial research in the country. Such people, who will also have to be the leaders of research in the country in future, are, according to Lord Rutherford, " rare, but are essential for the success of any research organization. *With inefficient leadership it is as fatally easy to waste money in applied research as in other branches of human activity.*" He, therefore, advocated a system of grants-in-aid or scholarships to approved students for post graduate training, and also urged the necessity of co-ordinating agencies in connection with research. Referring to the part played by such agencies, he concluded that:—

"*In Great Britain, the responsibility for planning the programmes of research, even when the cost is borne directly by the Government, rests with research councils or committees who are not themselves State servants but distinguished representatives of pure science and industry.* It is to be hoped that if any comparable organization is developed in India, there will be a proper representation of scientific men from the universities and corresponding institutions and also of the industries directly concerned It is of the highest importance that the detailed planning of research should be left entirely in the hands of those who have the requisite specialized knowledge of the problems which require attack. In the British organizations there is no political atmosphere, but of course the responsibility for allocating the necessary funds ultimately rests with the Government."

There can be no question about the very valuable services rendered by the Indian Science Congress Association during the past twentyfive years to the cause of science in India. As was however, hinted in our editorial for the month of December 1937, the time has come for devising ways and means for making the Association play its proper role of usefulness in the cause of scientific advancement of the country.

The Association has, as is well known, no permanent abode of its own and during fiftyone

weeks of each year its existence depends on the courtesy and generous help of the Royal Asiatic Society of Bengal. This arrangement, though it has proved satisfactory in the past, is not to the best interest of either of the two institutions, and, in our opinion, the time has come when the Science Congress Association in its own interest as also of its parent body, the Royal Asiatic Society of Bengal, should have a permanent office and a staff of its own. With the present arrangement a great deal of the work of the Congress, when not in session, cannot be carried out satisfactorily, while the absence of a permanent staff of its own involves a great deal of extra work for the Honorary Secretaries. Schemes are, we understand, already under consideration for having a permanent staff and headquarters of the Association. We shall, we hope, not be guilty of divulging any secrets in remarking at this stage that probably the greater part of the savings of the Science Congress Association during the last twentyfive years has been used up towards the celebration of the Jubilee Session, and it is, therefore, imperative that this very essential side of the Congress organization should be considered along with such proposals. In our opinion the endowment of the Association by some public spirited rich citizens of India alone would satisfactorily solve the problems involved, and we suggest that an urgent appeal to this effect should be launched before the country at as early a date as possible.

In regard to the Congress itself reference may be made to the fissiparous tendencies, provincialism, etc., which within recent years have become more and more pronounced in certain directions. In the interest of both the Association and scientific research in the country we would strongly urge that such tendencies should be quashed immediately and that the work of this Association should, as hitherto, be carried on in the interest of the country as a whole and not of any province or particular section. Further, the Association has, in our opinion, become much too unwieldly for efficient management. The number of its sections is unfortunately multiplying at too rapid a rate without any corresponding advantages. In 1914 the Science Congress started with 6 sections, and in the Jubilee Session there were no less than 13 sections, though a number of important subjects such as Education, Engineering etc. were not represented. Along with this, the number of papers communicated to each section is increasing at a very rapid rate, and this, as was remarked in our editorial for December 1937, is very unfortunate, as during the three or four active working days of each session it is impossible to read and discuss anything more than a very small percentage of the papers communicated. If this tendency is not curbed at any early date, and the number of papers not reduced very materially, the incubus of this heavy burden may, we are afraid, engulf the main functions of the Association, and more and more circumscribe its sphere of usefulness. We would therefore, strongly urge the adoption of some system by which the number of papers could be limited to not more than about 30-40 in each section. This would enable the papers to be read and discussed thoroughly and afford delegates attending the sessions from different part of the country more opportunities for taking part in the discussions, while, for subjects of outstanding importance in reference to various sciences and their utility to the country, discussions and symposia could be arranged.

We are also of the opinion that the present administrative machinery of the sections has not been properly designed, and as a result it is unable to perform the indefinite functions assigned to it in an efficient manner. We have yet to understand the exact functions of the recorders of sections, and, being similarly doubtful about the functions of the sectional committees, would very strongly urge the necessity for overhauling the entire machinery in this connection. Attention may also be invited to the somewhat unsatisfactory arrangements that exist at present in regard to the nomination and selection of the presidents of various sections. In conclusion, therefore, we would suggest that a reviewing committee should consider various details such as those mentioned in the above paragraph at an early date and evolve some scheme for a more efficient working of the Indian Science Congress Association.

Explorations in the Gobi Desert

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THE Gobi Desert offered a special challenge to the scientific explorer. It tempted him, for in all the world it was the largest land area about which so little was known. It defied him, because its distances are so vast, and travel is so difficult that the short summer passes before the explorer can penetrate far or finish his studies; and then the long winter brings frozen ground that prevents collection of vertebrate fossils, and snow that hides the rocks from the geologist.

Roy Chapman Andrews conceived the answer to this challenge. He sent out a caravan of camels in early March, carrying food for men and for motor-cars. A month later, we scientists with a small fleet of cars travelled into the desert, studying the land and collecting specimens. By the time our supplies ran low, we overtook the caravan and reloaded the cars with gasoline, oil and food, giving the camels our specimens to carry. Then the cars moved on, traversing in an hour as much distance as the camels could march through in a day. When we found an area that required more detailed study, we made a camp and the motor experts overhauled the cars while the scientists worked the region—on foot or with hired camels and horses. Later the caravan overtook us and again gave us food for motors and men, while we stowed our specimens in the boxes which had held gasoline. The camels most obligingly shed their thick wool in the summer, and we used it as packing for the specimens. Thus we could travel swiftly, work hard, and bring out our specimens during the brief summer season when scientific work was possible.

Not all sciences were represented, and we regret especially the absence of ornithology and entomology. Dr Andrews was the mammalogist, and he had three skilled taxidermists to prepare the skins and skeletons which he collected. He camped in the Altai Ranges to hunt the great-horned sheep and ibex, stalking them on foot for days to get a shot at these rare, wild citizens of the mountain-land. On the vast open plains he chased the fleet antelopes and wild asses in a motor-car at forty miles an hour. He trapped the smaller creatures, so that every mammal in Mongolia was represented in his collections; and every skin was perfectly prepared and catalogued.

Dr. Granger, the Palaeontologist, with four assistants, collected the vertebrate fossils which were buried in the sedimentary rocks. Many people believe that we found creatures of great antiquity even to the earliest of vertebrates; but this is not true. Our vertebrate fossil record began with the lowest Cretaceous. Dinosaurs and other vertebrates are found abundantly in other regions from much older formations than these. Popular belief also held that we had discovered the source from which many races of dinosaurs

: Small Dinosaurs.

and mammals evolved and migrated radially to all the world. This would have been very interesting; but what we actually found was even more interesting.

The fauna was complexly made up. The dinosaurs of the Lower Cretaceous were like those of the Jurassic of Europe, and so were some of the fossil plants—suggesting that the Gobi was isolated during these periods and did not receive immigrations from the outer world. A great change occurred during the transition from Lower to Upper Cretaceous, for in the latter we found not one of the earlier reptiles. All of the giant sauropod reptiles died out, and during the Upper Cretaceous time the Gobi was populated by rather small dinosaurs, closely related to those of America! Indeed one flesh-eating dinosaur is so like his Canadian cousins that Dr Gilbert would have called him by the same name if we had found him in America. And the *Protoceratops* that laid most of the eggs which we found, belongs to an American family. There must have been easy communication between the two continents during Upper Cretaceous time: and perhaps the connection was farther south than Behring Strait, as no dinosaurs are known in either continent within a thousand miles of Behring's latitude. The topography of the Pacific Ocean is so young that the present lands and seas give us no reliable clue to the configuration during Cretaceous time.

Eggs of *Protoceratops*.

The Age of Mammals is richly represented in the Gobi Desert, and we took thousands of mammal-bones from many Tertiary beds. Here, too, our discoveries were surprising, even to ourselves. One of the most interesting experiences was finding the highest Cretaceous in direct contact with the Paleocene. This meant that in a single locality we could study the latest dinosaur beds and the earliest mammal beds together, one resting upon the other. Here we hoped that the great gap between the Mesozoic and Cenozoic eras would be bridged; and that we could find a transition from the Age of Reptiles to the Age of Mammals; there might have been a mingling of the two faunae; there might have been primitive mammals in the one whose descendants appeared more highly advanced in the other. We hoped to shed some light upon the unknown cause of the extinction of all dinosaurs—an unsolved problem of biology and geology.

But here, as everywhere else on this planet, we found the fossil records wholly separate and distinct. In the Cretaceous rocks the dinosaurs were abundant to the very top; but not one survived into the Paleocene. The Cretaceous did indeed yield primitive mammals—but they were wholly different from the strange aberrant mammals of the Paleocene. Indeed the latter were more nearly related to fossil mammals of South America than to those of the Cretaceous beds just beneath them. Not a single creature was found common to the two rock-formations; and the rocks themselves showed a profoundly different composition, although both were inland sediments. We must conclude that there is a lost period—recorded only by disturbance and erosion—between the Age of Reptiles and the Age of Mammals.

The mammal record held many surprises. We had expected to discover the five-toed ancestors of the horse; for in America the earliest of the horse-tribe had already lost one toe. And since Asia was the home of the domestic horse, we hoped that we would find horses or their ancestors in all the formations of the Age of Mammals. But exactly the reverse was true; for we found no horses older than the *Hipparion* of Pliocene time. The horse must have emigrated to Asia after evolving in America. He must have travelled to meet his Asiatic comrade, Man, almost at the time when Man had evolved so highly that he could begin to use the horse. I grant that the word "almost"

is a bit figurative, for there is no evidence that Man domesticated *Hipparion*, which was almost as good a horse as *Equus*. But the proof of the separate evolution and dramatic meeting of these two comrades, Man and Horse, was one of the unexpected results of our studies.

Another surprise was the discovery of titanotheres in Asia. Our Museum's President, Henry Fairfield Osborn, had just finished his great monograph on these huge-horned beasts of the Western Hemisphere, when Dr Granger found titanotheres in the Gobi Desert—the only part of Asia, I think, where they are known. The most primitive titanotheres are found exclusively in America where their race evolved into big, formidable brutes before they migrated to Asia.

Many other mammals showed affinity with America; but many were Asiatic, or even exclusively Gobian. We found bones of the giant hornless rhinoceros, *Baluchitherium*, which was known also from Baluchistan and from Western Siberia. But the extraordinary *Embolotherium*, with great bone humps—not horns—on their noses, are citizens of the Gobi, and we do not know any similar creatures from other regions. Perhaps their nearest relatives are the titanotheres. Another exclusive Gobian was the gigantic dog-like carnivore, *Andrewsarchus*, whose head was thirty inches long. He was bigger than the largest bears; and a tiger would have looked dwarfish beside him.

Thus the life-record of the Gobi is a complex tale of native Asiatic creatures evolving into more advanced forms, while immigrants from other lands came seeking a homeland within the Gobi, or a highway to still farther countries. In this brief account, I have omitted the elephant-tribe, which, originating in Africa, sent at least three invasions into the Gobi, in three separate periods. The primates sent two invasions, one of baboons and one of men, during diverse periods. I have also left out the tiny mammals of the Cretaceous beds, because they deserve a long article.

The Anthropologist joins hands with the Palaeontologist in the study of Man. In our first Expedition I brought in a few weathered stone implements from the Altai Ranges. In our second field season, Dr Granger and Mr Olsen collected half a dozen more in the valley north of the red cliffs where the dinosaur's eggs were found. These discoveries justified our bringing Dr Nelson as Anthropologist for our third journey. He found the artifacts of a series of Stone-Age civilizations. The oldest culture gave him only simple, weathered stone tools and weapons. But each later culture was more complex than its predecessor, until we had stone arrow-heads, points for spears and darts, pottery, fire-hearths and beads. Some of these ancient implements and even cultures resemble accurately certain of those found in India. The Stone-Age civilizations of the Gobi preceeded the use of metals; but traces of iron and bronze were found in the graves which recorded still later civilizations. Thousands of artifacts were collected, and are now being studied at the Museum by Dr Nelson and his colleagues.

In that same season Dr Ralph Chaney accompanied us as Palaeobotanist. The desert yielded very few fossil plants, and most of them are poorly preserved. Dr Chaney took all that he could find, and made a splendid collection of all modern plants of the Gobi region.

Dr Charles P. Berkey and I made 6,000 miles of geological cross-section along all of the routes of the Expedition, mile by mile. During the first two years we also made 1,500 miles of route-maps, and plane-table surveys of more than 1,000 square miles. The topographic work was taken over, during the third season, by Major L. B. Roberts with two skilled assistants. The geologists collected a great series of rocks which have been studied with the collaboration of Dr George Bain. Our marine fossils have been studied by the renowned Palaeontologist, Dr A. W. Grabau, who described them in a great monographic volume.

Let me close with a sketch of the geological story of the Gobi. Upon a complex of ancient gneisses, the sea crept in and laid down limestones and shales, and a vast thickness of graywackes and argillites—all of Palaeozoic age, and chiefly of late Palaeozoic. After Permian time a great revolution folded all of these rocks, and big masses of granite invaded them, converting many of the shales to schists. Then the mountain-ranges were slowly worn down, probably during Triassic time, for no

rocks of that period are known in the Gobi. During Jurassic time the Gobi formed many intermontane basins, when conglomerates, lavas, tuffs, shales and even thin, poor coals accumulated. Another disturbance tilted and faulted the Jurassic rocks of the Gobi and of China. Again, the mountains weathered away, and the Gobi warped gently into a broad, shallow basin—or series of basins, where the thin beds of Cretaceous sediments were laid. Most of these are less than 200 feet thick, and none exceeds 2,000 feet. Few are conglomerates—almost all are clays and sands, implying that the land was not high or rugged at that time. The early Tertiary formations are even thinner than the Cretaceous beds, and almost all are fine-grained clays and clay-sand mixtures. We found many deposits of Eocene and Oligocene Age, representing successive divisions of each period; but Miocene beds are almost absent. The uplifted mountains of today are bevelled by a nearly perfect peneplane which must have been completed during the late Miocene or early Pliocene; so we judged that the land was being eroded during Miocene time, and most of the sediments were carried out of the Gobi region. Thus the peneplanes give us the clue to the reason for the scarcity of Miocene deposits. Only two formations of this age are known thus far from the Gobi, but both have yielded important fossils. Early Pliocene deposits are also rare, but during the late Pliocene time the mountains began to rise and the basins began to warp, and the land began to take its present shape. We find abundant deposits of late Pliocene Age, and thick, coarse conglomerates of the Pleistocene border the new mountain ranges and spread as thinner gravels far over the desert. During the rainy epochs of the Pleistocene, large rivers carved broad valleys in the Gobi; but during the dry epochs, bedlands and undrained hollows formed and the river systems disintegrated, each river straggling to its death in a sandy delta or a salt lake

The present desert is young, for it has existed only since the latest rainy epoch of the Ice Age gave place to the dry climate of today—presumably between 20 and 30 thousand years.

Thus the Gobi Desert tells its story like a minstrel, to those who will learn its language and give heed to its voice. And in this it resembles all other lands, including India, whose song I have heard now for three happy, interesting months.*

* Based on a lecture delivered by the author in the Pose Research Institute, Calcutta.

Ancient Paintings in Spain

Notwithstanding reassurance as to the adequacy of the measures taken to protect the artistic treasures of Spain, archaeologists have been much perturbed lest the priceless Palaeolithic paintings of the caves of northern and eastern Spain, both within the zone of military operations, should suffer damage. Professor H. Obermaier of Madrid has now been informed by a journalist, who had himself visited the famous cave of Altamira, near Santander, which contains the pictures of the bulls, the first Palaeolithic paintings to be discovered in Spain in 1835, that they were still undamaged in September last, although the cave had served to house some hundreds of refugees, and the house of the guide had been occupied by a member of the "Red" staff. From other sources information has been received that in the other caves of northern Spain in which there are paintings, they also are intact. Nothing, however, is known of the fate of the paintings of the eastern school of Spanish Stone-Age art, of which some of the most important are in the caves of the province of Turuel, the scene of recent fighting.

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The Intelligent Man's Guide to the Production and Economics of Electrical Power

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EVER since the dawn of civilization, man has been endeavouring to utilize the gifts of Nature to his own benefit. The degree of civilization attained by a people depends upon the rate of useful work turned out, in agriculture, industry, transportation, and other forms of human activity. But for the production of all kinds of work, supply of power is essential. In the early stages of civilization, only manpower (power of muscles) was used. At a later stage, however, animals were domesticated and donkeys, bullocks, but, most of all, horses were used for doing useful work. To this must be added slave labour. Even in the earliest societies, attempt was made to utilize such forces of Nature as were easily available, such as wind-power for the propulsion of boats and ships. During the Middle Ages power of wind and power of running water were used for milling wheat, running saw-mills, etc.

Invention of the Steam Engine

The invention of the steam engine in the last part of the eighteenth century and its application to all kinds of industrial work pointed to another source of power. These were the coal deposits. It was realized for the first time that a tremendous amount of energy was lying locked up in coals of different types, and the countries which were fortunate in having rich coal-mines were sure to lead in industrial and material progress. Besides coal, other sources of energy are peat (half-converted coal), wood, oil and shale. Oil became important only after the discovery of the internal combustion engine in the nineties of the last century by Otto and Diesel.

Electrical Power

That energy liberated in chemical reactions could be converted into electrical energy was illustrated by Volta, but the real significance of electrical current as a convenient tool for human use was realized after the discovery of the laws of eletromagnetic induction by Faraday in the year 1831. Nearly fifty years passed before machinery, which rendered production and distribution of electricity on a large scale possible, was perfected. The story of public electrification begins from the year 1880 when Sir Joseph Swan produced a commercial type of incandescent lamp, and Edison designed the first generating station and started public lighting.

Now electricity is, as every college boy knows, produced by the motion of the armature (an iron core wound over with copper coils) in the magnetic field of an electromagnet. The essential point is to obtain power for the running of the dynamo. This can be obtained either by harnessing water-power, or by the use of a steam-engine which itself derives its power from the burning of coal or wood, or by an oil-engine which derives its power from the combustion of petrol (Otto Engines) or crude oil (Diesel Engines). So the ultimate source of power is either *running water, coal, oil, peat, or even wood*, and shale, or any other kind of fuel (such as power alcohol, or bagasse).

The older type of steam engine used in locomotion was very inefficient. In fact, barely five per cent of the energy derived from the burning of coal could be converted to electrical energy. It appeared for a time that electricity produced from coal had no chance of standing against electricity

obtained from water-power in point of cheapness. But a revolution was brought about at the close of the twentieth century by Parsons' invention of the Steam Turbine. This rendered the construction of large and economical plants for generation of electricity out of coal possible, and electrical power could now be offered at competitive rates with steam-power.

The Balance Sheet of Power for Different Countries

The total output of work by a country or a political unit, depends upon the total power it can command or develop. Hence every country has to give careful consideration to the proper survey of its power resources (water power, coal, peat or oil), and to the methods for their development for industrial uses. For this purpose it is necessary to have beneficent legislation, a properly maintained power survey department, and institutions for training the requisite technical staff. Countries differ in their possession of power resources. The U. S. A., the U. S. S. R., and to a lesser extent, India are the great countries in the world which are fortunate in possessing all kinds of power resources in abundance. The U. S. A. has developed her power-resources to the fullest extent, and the U. S. S. R. which before the war, was even ignorant of its power resources, has taken steps (under the various Five Year Plans) which have transformed it within a short time from an agricultural country to an industrial one. Of the other great countries, England and Germany are almost unique in that they possess almost no water-power but plenty of coal of every variety. On the other hand, amongst the great powers Italy possesses no coal, and has to depend almost entirely on water-power; the same is true about Switzerland and Norway. We shall see in a later essay now these coutries have developed their power resources. Before taking up this task, we are explaining a few technical terms which the reader will constantly come across.

Unit of Power—Horse-power, Kilowatt

Work in mathematical language is the product of forces and distance through which it acts. If one pound-weight be raised through a height of one foot against gravity, we say that the work done is one foot-pound. If we measure the weight in grammes and the distance in centimeters, the unit of work is called an erg. This is the work done when one gramme weight is raised by one centimeter against earth's gravitational force. From the definition of work, it is clear that the work done in raising a ton of weight one foot against gravity is the same as raising a pound to a height of 2240 feet. A man cannot generally raise a ton's weight at one effort, but he can do it in parts, the only difference will be that in the second case greater time will be taken in performing the same amount of work. In popular language, this is disposed of by saying that a man does not possess sufficient power to raise a ton's weight through an appreciable distance.

In technical language '*Power*' refers to the rate at which work is done, that is to say, it is the product of force and speed. The same machine can exert a greater force with a smaller speed and a small force at a great speed. If the work done is measured in foot-pounds the practical unit of power is known as one horse power or 1 H.P. If an agency can do 550 foot-pounds of work in one second we say that its capacity is 1 H.P. If the work is measured in ergs (c.g.s. system) the power is measured in ergs sec. This unit is too small and a unit which is ten million times larger is employed. This is known as '*Watt*' after James Watt, the discoverer of the Steam-engine. Even 'Watt' is too small when we take into consideration big machines and so another unit which is thousand times larger than a watt known as 1 kilowatt, or 1 Kw. is employed. In the present article this unit will be freely used. It can be easily proved that 1 H.P. is equal to 746 watts. We can also rate other varieties of power in terms of the kilowatt. It has been estimated that an average man at a stretch can wield only 1/10 H.P. or .075 Kw.

The Unit of Electrical Energy

Electrical energy is measured in Kilowatt-hours written as KwH for the sake of brevity. If a unit current (one ampere) flows under a pressure of 1,000 Volts for one hour, one unit of electricity is consumed. This, like mechanical energy and

heat, is an energy unit. The equivalent of this in energy units is 860 kilocalories. (One KwH will therefore produce sufficient to raise 1.33 litres of water from zero degree to the vapour state). If an incandescent lamp is rated at 50 watts, it will consume one unit of electricity if it works for 1000/50 = 20 hours. An average man works generally for 8 hours and his output is therefore equivalent to 0.6 units in a day. Man, regarded as an animal producing work, is a rather poor specimen!

Total Power Installed

It is a difficult business to make an estimate of the total power developed in a country, as it is made up of electrical power, steam power, power from oil engines, man and animal power. The first three kinds of power are easy to estimate. If a generator is capable of supplying unit current at a pressure of 1000 Volts, it is said to have a power of one kilowatt installed. The steam and oil engines are rated in H.P., which can be easily converted to kilowatts.

At the present time, man and animal power forms, in a progressive country, a very small fraction of the total power available from electricity, steam engines, and so on. Thus the total electrical power installed in Calcutta and its suburbs is about 100,000 Kw., and steam power will probably amount to 150,000 Kw. Total power available from machine of all kinds will probably amount to 300,000 Kw. Let us compare this with the man-power of Calcutta. Supposing that the total labouring population of Calcutta and its suburbs is 500,000, their total power is only 30,000 Kw., *i.e.*, only 1/10 of the power derived from machines. In more advanced countries, the proportion is still larger. In the countryside, only man and animal power is used.

The Total Work Output of a Country

The total output of work in a country can be easily measured in KwH. In a country where the only source of power is electrical as in Norway or Canada, the estimation is easy; for every generating station records its output of work, and an estimate for the whole country is obtained by adding up the returns for all the stations. In a country where much steam power or oil power is directly used, estimation becomes more difficult, as it is difficult to get records of output of steam and oil-engines. For a backward country like India or China, the man and animal power, which can be entirely neglected for advanced countries, forms the chief item. The following table shows the output of electrical energy for a few different representative countries of the world, for two

TABLE I

Country	Year	Total Consumption of Electricity per year in millions of units.	Units Consumed per head of population per year.
Great Britain	1926	11374	300
	1935	23600	600
Germany	1926	21218	300
	1935	34500	530
Italy	1926	7644	200
	1935	12800	300
Switzerland	1926	4170	1100
	1935	5705	1150
Norway	1930	2400	600
	1935	7143	1600
Russia	1926	3608	20
	1935	25900	150
U. S. A.	1926	90300	750
	1935	123236	950
Canada	1926	12093	1300
	1935	21362	2000
Japan	1926	9313	160
	1935	21000	350
India	....	Definite statistics are not known	7 approx
	....		

THE INTELLIGENT MAN'S GUIDE TO THE PRODUCTION AND ECONOMICS OF ELECTRICAL POWER

Table I shows why certain countries are rich and others are poor. It is easy to see that the greater is the work output of a country the greater is its wealth.

Now, the energy output per head of a modern advanced country is afforded by the example of Norway or Canada. It is about 1000 KwH per head. Such a country, being all electrical, probably uses no other kind of power in appreciable amount. Let us compare this with a country like India. The energy output is made up of electrical power, steam power *plus* man and animal power which cannot be neglected in this case. The electrical energy per head in India yields 7 units, and we shall not probably be far wrong if we suppose that the total steam power yields 8 units. The total energy output of an average man working for eight hours daily is .6 KwH, and for a year of 300 working days, the total amount is 180 units. But only about a fourth of the people are engaged in useful work, so that the average output per man is not more than 40 units. Animal power will add another 10 units to it. So the average energy output per man in India is not more than 65 KwH (40+10+7+8). The total work output per Indian is about 30 times less than that of Canada. Now wealth does not fall from the heavens, but has to be created by human or machine power. This explains why the average Canadian or American is 30 times richer than the average Indian.

The cases of other countries are also interesting. England, Germany, the U.S.A., and France use, to a large extent, steam and oil power, and probably if they are added together, the total output of energy per head per year for these countries would not differ much from that of Canada or Norway.

But Italy and Japan present quite different aspects. Of all the great powers, these two countries are very deficient in coal and petrol. They have therefore to develop their water-power resources to the fullest extent. Even with tremendous efforts, they have not been able to provide more than 300-350 units *per capita*. This is one of the reasons of the comparative poverty of these countries, and hence they are always anxious to secure other undeveloped resources belonging to less advanced nations.

The Case of Russia

Russia like the United States of America possesses a large variety of power resources. But before the Revolution, these resources were lying unutilized and only an insignificant part was developed, mostly by foreigners. The rulers of Russia used to wage costly and ruinous wars in the interest of imperialism in distant countries while her peasants were subjected to periodic outbursts of famine and pestilences, and were usually half-starved and half-clothed. They were unaware that the means of removing the country's poverty lay near at hand and depended upon the development of the country's resources. After the Revolution, the new Russain State set determinedly to solve the problem of the country's poverty and this brought into existence the various Five Year Plans; the whole country was surveyed by competent persons under the direction of the Krzhizhanovsky Institute of Power Research and Survey, and it was discovered that Russia ranked first in its oil, peat and water power reserves in the whole world and second in its coal deposits. She also has the largest forest area on earth. It was decided to electrify the whole country in order to utilize its resources for supply of cheap power to promote a rapid development of her industries. In five years' time, a large part of the programme was carried out and the production of electricity was increased nearly eighteen times. Today we find Russia leading the way in electrification schemes and ranks only second to the United States of America.

Economics of Energy Production and Supply

The economics of energy production and supply can be grasped by the lay reader only if he has a clear idea of the uses to which electricity can be put. The earliest use of electricity was for lighting, particularly public lighting (lighting of roads and public places). But in this line the electric supply companies had to bear the competition of other forms of illumination, particularly of gas-lighting.

It was only the lowering of the price of electricity and invention of better kinds of glow lamps which saved lighting for the electrical industries, after a rather long struggle.

But to-day, electricity consumed in lighting forms a very small fraction of the total amount. The purposes to which electricity is put can be grouped under the following headings:--

(*a*) Domestic purpose (lighting, heating, and in our country fans and for running small machinery for household uses);

(*b*) For Traction (for running tramways, electrified railways etc.);

(*c*) For Industries of all kinds;

(*d*) For Agriculture.

A little reflection shows that electricity is not equally suitable for all purposes. For example, electricity for lighting is required during the night-time, say, only for four hours out of twenty-four. For cooking, it is also required only for a short time. Fans are in use in our country only for about 6 months, and for about five or six hours per day. But a company which has undertaken to supply electricity to a city has to maintain machinery which can meet the maximum demand (peak load) at any time of the day and the year. Suppose this is 3,000 Kw. The company has to maintain machineries capable of delivering 3,500 Kw. But the total demand at any hour of the day is only a fraction of the total reserve. Let us suppose that at 11 A.M., the total demand is only 700 Kw. Then only 20% of the total available power is being utilized. This percentage, *i.e.*, the power used at any time to the total installed power is called the ***load factor***. If electricity is used for domestic purpose alone, the load-factor is very low. When the load factor is low, charges are bound to be high.

But for traction and industrial purposes, the local factor is much higher. Certain kinds of work may go on for all the 24 hours or nearly so, *e.g.*, raising water for a municipality or work in a factory where labourers work in three shifts, each of eight hours. Generally for industrial purpose, the use of electricity is regular, and lasts for longer hours. Hence the load factor is very high, and the charges are proportionately low.

For agriculture proper (ploughing, sowing, harvesting and irrigation), in general, electrical power is not very suitable, except for some industries connected with agriculture, such as threshing, milling, crushing, etc. For the ploughing of the ground, and sowing of seed, and raising water for irrigation purposes are not continuous processes, but are confined only to certain seasons, and to certain hours of the day.

The load factor varies from hour to hour as mentioned above and is different in the different seasons of the year. We therefore speak of the average load factor for the year or for the day. It can be easily realized that the load factor plays a very important part in the economics of electricity rates.

(*To be continued*).

Scientific Research and British Industry

THE Annual Report of the Department of Scientific and Industrial Research opens with an eloquent tribute to the late Lord Rutherford and his inspiring leadership during the seven years he was Chairman of the Department's Advisory Council. The Reports which have appeared annually over his signature during that period all bear testimony to the strength of his conviction that the prosperity of this country can only be assured if its industries make the fullest use of the technique and the discoveries of science. His last act as Chairman was the shaping of the present Report which is signed by Lord Riverdale (formerly Sir Arther Balfour), the new Chairman of the Council.

During the year, consideration has been given to two directions in which it may be possible to strengthen the contacts between industry and the National Physical Laboratory. With improved conditions of industry the basis of the charges made for special investigations and tests has been reviewed, and it is anticipated that some reduction of the charges may be possible in particular cases. Arrangements have also been made by which the staff of the Laboratory will be available to visit works to study practical problems of production and to plan investigations and carry them out on suitable terms under the conditions obtaining in manufacturing practice. The new development is one which should prove attractive to industry.

The Report records substantial progress in practically all directions of the Department's work, both in the researches carried out by the research establishments of the Department itself, and in the laboratories of the research associations, formed on a co-operative basis in various industries under the Department's auspices. The associations' financial resources, encouraged by the present conditions of grant, maintain an upward tendency. The aggregate income subscribed by industry has now practically reached £250,000, and the Government's grants amount to nearly half that sum.

During the year the Pottery Manufacturers' Federation decided that the time was opportune for the setting up of a research association for their industry. To finance the project the Federation has guaranteed the new research association an income of at least £10,000 per annum for five years, and the Department has agreed to make a grant of £5,000 a year, so that the new association begins its existence with an assured income of at least £15,000 a year. There is also a possibility of increasing this to £19,000 if sufficient money is provided by industry to earn the full grant which has been offered by the Department.

The Storage and Transport of Food

A short time ago a new system of refrigeration was developed at the Ditton Laboratory of the Department, known as the "jacket" system. The new system has been installed with modifications in most of the new tonnage in the Australian and New Zealand trade, and during the year arrangements were made for officers of the Department to sail in some of the ships so equipped to examine its practical working. The basis of the investigation had to be wide since the system involved changes in the method of carriage of all the ships' refrigerated cargoes frozen, including butter, cheese, frozen meat, chilled meat in gas storage, pears and apples. In the tests some 350 electrical resistance thermometers spaced throughout the cargo were used. The full data obtained from the expedition are under detailed consideration, but the indications are that the new system is working very satisfactorily. In the great bulk of a stack of 50,000 cases of apples the temperature was uniform within ½°. Moreover with the new system 3,000 more cases can be carried than with normal storage. The Report points out that at the present time the margin of uncertainty in

specifying the best temperature for a mixed cargo of apples is about 2°F. Thus the precision of control possible in the refrigerated space aboard ship has come abreast or even surpassed the precision demanded by biological definition.

The success that has attended the commercial development of gas storage of home-grown apples, that is storage in an atmosphere containing just the right amount of carbon dioxide, is well known. A second investigation carried out with William pears and with Conference pears has shown that the pear responds to gas storage even better than the apple. When gas-stored, the pears ripen more slowly on removal from store, thereby allowing the trade more time for marketing them. Since the value of pears consumed only in the United Kingdom is approximately £2,000,000, and home production is responsible for only a small amount of the total, there would appear to be scope for a considerable increase in the growing of pears in this country.

To meet the increasing demands of the trade for information as to the behaviour in store of fruits and vegetables not previously stored in quantity, trials have been carried out with strawberries, hot-house grapes, broccoli and peas. The previous work with plums has been extended, and gas-storage trials with asparagus have been commenced.

The Shoe and the Foot

Interesting work has been carried out during the year by the Boot and Shoe Research Association arising from investigations on "walking research" in which moving picture records are taken of the gait of various people to study in detail the way they walk. The full results of this investigation will not be available for some time. As a result of knowledge already gained, testing machines have been designed for laboratory investigations of the response of different kinds of shoes to the forces acting on them during wear. One of these is a flexibility meter. In dress shoes flexibility gives comfort and elegance, and an instrument, the Report states, which imposes on a shoe the correct kind of deflection and gives a measure of flexibility provides a means of investigating the different ways in which this flexibility property can be achieved.

A second instrument investigates the character of the shank or waist of the shoe, a very important feature in high-heel shoes, and a third, not yet completed, is a machine which will put shoes through the motion of walking and give the soles the treatment they receive during wear. The object of this machine is to give information on the materials and constructions likely to give maximum durability in various circumstances.

Another matter the Boot and Shoe Research Association has been investigating is the standardization of shoe size markings. Most individuals have had experience of lack of uniformity in this connection. For example, a lady may have a pair of shoes giving perfect satisfaction and comfort, marked a certain size. She changes to another type of shoe or perhaps the same type from another manufacturer, and may find it necessary for the same comfort to go to some quite different size markings. Certain standardization rules have now been formulated which were adopted at a recent joint conference representative of all sections of the industry.

A third matter, the Report states, which has come up during the year is the question of occupational footwear—the need for designs and specifications of boots and shoes suitable for various kinds of industrial occupations. For example, what is the best kind of boot or shoe for a waitress to wear or a nurse, a shop assistant, a policeman, a railway porter, a factory machine minder, and so on? Many large concerns and authorities take a great deal of trouble, and have a high degree of organization, in the welfare of their employees, and doubtless they would not hesitate to specify a certain shoe as part of their employees' uniform if they knew with certainty the best type of shoe for their special circumstances. "Safety boots" for miners and quarry workers is a case in point.

Sweets

Children should be interested in the researches of the Jam, Cocoa and Confectionery Research Association. A special study of toffee manufactur-

ing is being made. In particular the effects of variations in the properties of condensed milk on the manufacture and keeping properties of toffee is being investigated. Pastilles or gums, the Report states, are frequently made with a basis of gelatin. In a certain case these pastilles were found to become tough and almost completely insoluble in the mouth. An extensive examination of these goods revealed that the effect was due to an action between the gelatin and certain of the flavouring essences used. Thus manufacturers of these goods are now able to avoid the occurrence of this defect.

Of Interest to Motorists

The report gives a summary of the work of the Research Committee of the Institution of Automobile Engineers which forms the co-operative research organization for the motor industry and is financially supported by the Department.

In the progressive development of the automobile, one problem after another is thrown into prominence and, at present, considerable attention is being given to matters affecting the life and performance of engine bearings. The work of the Committee has included an examination of the influence of bearing materials, lubricants, operating conditions, etc., but probably the most outstanding development during the year is the new technique for the measurement of the temperature of bearings on high speed engines. The experiments already carried out have thrown a flood of light on certain factors affecting bearing temperatures.

The investigation on cylinder wear, which is nearing completion, has undoubtedly been the biggest research undertaken by the Committee and it will constitute a very exhaustive examination of the many factors responsible for cylinder wear. A recent enquiry amongst manufacturers and operators indicated the marked effect this investigation has already had in reducing the severity of a trouble which has cost the public sums which, while difficult to assess, must amount to several millions of pounds per annum. One interesting recent development in this research has been the application of a new method of studying the formation of a lubricating oil film on the cylinder walls, a method which has already shown itself capable of giving quantitative data in place of mere guesswork.

Strenuous efforts are being made by the automobile industry to reduce all kinds of noise on motor vehicles and, in this connection, the Committee's investigation on brake squeak has been continued, while two new researches, one on the silencing of motor cycles and the other on the noise emitted by motor-car body panels, have been started.

Other work of interest to motorists is being carried out for the Department's Illumination Research Committee, at the National Physical Laboratory, on the best colour for street lighting. The problem is, the Report states, to distinguish rapidly and with certainty objects of various sizes and shapes which may appear suddenly on the surface of a lighted street. The method employed is to take a number of "still" photographs of a street, with and without different objects placed on the road surface. A film is then made of these photographs and this film is projected on to a screen in which are small holes at the places where the images of the street lights would appear. Behind these holes are placed lamps, giving light of the same colour as that used for projecting the picture, to represent the street lamps: in this way it is possible to get sources sufficiently bright to simulate on the screen the appearance of an actual lighted street. By careful control in the making of the photographs and the film, it is possible to reproduce closely the actual street scene in all the details affecting an observer's ability to pick out objects in the street which appear and disappear during the course of the film.

In connection with the work of the Road Research Laboratory it is necessary to know in studying the durability of road carpets, not only how many tons of traffic have passed over the road but how many tons have passed over when the road was wet and how many when it was dry. To determine this an instrument, known as a wet road clock, has been developed, which records the periods during which the road is wet. The instrument depends on the difference in the electrical

resistance of a wet and a dry surface. Contact strips have been laid on the surface of the Colnbrook By-pass close to the Laboratory and the signals given when the traffic passes over these are recorded on an instrument in the entrance hall of the Laboratory.

Metals: Iron and Steel

A large amount of work has been carried out both at the National Physical Laboratory and under the Iron and Steel Industrial Research Council of the British Iron and Steel Federation, the co-operative research organization of the industry. Under the Research Council an investigation is being made to determine the gas temperatures in various parts of a blast furnace, the gases are also being analysed as well as solid samples taken from various portions of the furnace. This work is bringing to light the effect of ore size. Work on fundamental problems of heat transfer and their influence on furnace design has also been begun. It is stated that definite improvements in the life of the bricks used in building blast furnaces have resulted from the work of the British Refractories Research Association. Investigations are now being extended to the problems of open hearth furnaces. Researches are being carried out to determine the best type of coal for use in gas producers, a plant from which gas, for use in iron and steel furnaces, is made. Investigations have been carried out on problems relating to steel castings and to the life of ingot moulds. Work on the investigation of atmospheric and marine corrosion has been continued and attention is now being given to the surface treatment of iron and steel and the effect of coverings of paint and other protective coatings against corrosion.

The new balance blast cupola designed by the Cast Iron Research Association is continuing to develop satisfactorily. Some 170 furnaces are now in operation or under construction. Two investigations have been completed by the Research Association during the year, one on the laboratory and foundry behaviour of metallurgical cokes and the other on synthetic moulding sands made by bonding sands, clay-free or otherwise, with special clays. Fresh work has also been begun on problems connected with the vitreous enamelling of cast iron.

Following recent developments in the field of high-duty cast irons, such as their successful application to automobile crankshafts, camshafts, brake drums, etc., an important investigation has been begun during the year, sponsored by the Institution of Mechanical Engineers, on high-duty cast irons for general engineering applications. In this investigation the whole field of cast irons is being explored over a wide range of carbon content, both plain and alloyed, ordinary and heat-treated, and their mechanical properties determined. The National Physical Laboratory is co-operating in the work. The cast irons containing aluminium are also being investigated.

Non-Ferrous Metals

The British Non-Ferrous Metals Research Association has fifteen major researches in progress. The increased concentration of copper in the outer layer of ingots and castings of light aluminium alloys and of tin and tin bronzes produced under certain conditions is being studied. Work is also in hand on the study of the effect of bacteria occurring in certain waters on the corrosion of condenser tubes. The scientific principles underlying the production of mirror bright deposits of nickel which do not require polishing are being investigated. The protection against corrosion and wear given by electro-deposit coatings is largely a question of their thickness and uniformity. A reliable, quick and simple method for testing the thickness of a coating at a given point has been developed. The practical application of the test is mainly to nickel plating but it may also be applied with suitable modifications to copper, bronze, zinc and cadmium.

New buildings are being erected by the Association in Euston Street, London, in which ten to twenty thousand square feet of laboratory accommodation will be provided. It is expected that the new laboratories will be occupied during the present year.

Textiles: Cotton

Last year has been one of great activity in all departments of the Shirley Institute, the head-

quarters of the Cotton Research Association. For many years the Association has been equipped with spinning and weaving machinery and it has now been decided to instal a representative range of finishing machines for scouring, bleaching and dyeing, in order that some of the vast amount of fundamental research work on finishing problems, the results of which have been accumulated, may be applied more directly to the trade's special problems. Hitherto the Research Association has concentrated mainly on improving the properties of the materials used in industry and increasing the quality of the products made by it with existing equipment. Little work, the Report states, has so far been done towards creating new machines or more efficient equipment. There have, however, been exceptions, the most striking of these being the recent researches into new methods of opening and cleaning cotton.

This work is developing with great promise, but not as quickly as is desirable. This is largely because the development work in connection with each new machine is slowed up by the fact that the actual constructional work must nearly all be carried out for the Association by machinery firms, which are equipped mainly for mass production rather than experimental constructional work. Consideration of this and of the general question of extending the work of the Association to the development of more efficient textile machinery has led to the authorization of further large extensions in order that the Association shall be equipped to develop rapidly any new ideas connected with textile machinery, and to produce at the Shirley Institute the first model of any new machine. No question of production of machinery in quantity is, or is ever likely to be, contemplated.

The extensions will consist of two main blocks. There will be an engineering shop with sufficient equipment to enable the Association to build up new designs with the least possible delay. There will also be an extension of the present machinery rooms, and in this department the experimental work concerned with the behaviour of cotton in the new machines will be carried out. There will also be room for the installation of all the new machines developed for some time to come, so that members of the Association can see them in operation at the Institute and, if they so wish, have tests on their own materials carried out there.

Wool

Efforts are being made to secure extended and more stable support from industry for the work of the Wool Industries Research Association. A proposal seeking to obtain agreement in the various branches of the industry for the raising of funds by means of a statutory levy, while obtaining substantial backing from trade federations and individual firms, failed to gain the necessary majority opinion. Recourse has, therefore, had to be made for immediate purposes to an appeal for increased voluntary support, the results of which are still awaited.

Considerable attention is being given to the chemical treatment of wool to reduce shrinkage. With all the methods used there is the danger of overtreatment which produces a harsh handle in the wool and a deterioration of resistance to wear. Laboratory technique has been developed which has proved of great value in determining the modifications produced in wool by various treatments. The method is useful not only for the control of treatment but gives information as to the sort of treatment an unknown sample of fabric has received. The technical advantages of various treatments depend both on their cost and on the accuracy of the control which can be exercised. This latter factor, the report states, is of extreme importance in certain applications such as that required for treatment of wool before it reaches the stage of yarn. Thus in most " wet " treatments, if overtreatment is to be avoided, it is only possible to give a partial treatment to yarn fabrics. Thereby only the fibres on the outside of the yarns are attacked, which produces only a temporary effect in reducing shrinkage, since on washing, the yarn fibres are disturbed and the untreated fibres at the core then become capable of producing felting.

In co-operation with the Rubber Growers' Association research is being carried out on the use of rubber in conjunction with wool. By the use of suitable agents, the report continues, rubber can be deposited from latex on the surface of the individual fibres of a yarn fabric or felt much in the manner of a dyestuff, absorption proceeding

until the solution is exhausted. One of the applications of this principle is that yarns can be rubber-treated in hank form as in a dye bath. The material so prepared has increased strength and resistance to abrasion. The process has been made the subject of patent applications which, it is hoped, will be developed commercially in various ways.

The Civil War in Spain has limited the supplies of olive oil which is the traditional wool lubricant used in the worsted industry. The use of a substitute oil may lead to difficulties unless careful tests of it have been made. Apart from deterioration in combing and spinning performance, serious troubles may arise in the finishing of cloths in which yarns containing oils of a different nature are employed. Under commercial scouring conditions differences in dye absorption may be produced by residual oils so that the fabric would dye unevenly. Fifteen different substitute oils have been examined of which eight have been subjected to careful tests under mill conditions. The results have shown that several oils are now available which are not inferior, and in some cases are superior, to olive oil. Differences have been observed in the scouring of such oils but if careful attention is given to the conditions of scouring no differential effects need be experienced.

Linen

The experiment in growing flax on the royal estates in Norfolk has been continued and a crop of approximately 2,000 tons was harvested last year. New methods of treating the straw and handling the fibre now meet with considerable approval from the Irish spinners. A useful quantity of first class pedigree seed has also been successfully marketed. Investigations on the breeding of a still further improved variety of flax are in hand at the Association's Flax Research Institute at Flitcham. The Association's new flax breaker has been thoroughly tested out and it has been kept at work on a crop from 20 acres of flax grown in Scotland in 1936. The trial demonstrated that flax of an excellent quality can be grown in Scotland and the seed from the crop has been saved. A larger area is being tried in the same districts. During the year, the report states, work has been continued on the process of spinning a new type of linen yarn, the chief characteristics of which are its soft bulky nature, in fact closely resembling wool yarn with the advantages of the washability and non-shrinking of linen. The spinning process has been greatly improved and is now proceeding on a small commercial scale, with a view to development of fabrics for particular purposes where these properties will be most useful such as in knitted clothing fabrics, blankets and so on.

A new design of portable ultraviolet lamp for the examination of oil stains in cloth and the identification and testing of dyes in fabrics has been completed and the lamp has been placed on the market by a British firm.

Electrical Research

Dealing with the work of the Electrical Research Association, the report states that the researches on the properties of steam and of alloy steels suitable for use at high temperatures have played a large part in the improvement of efficiency in steam power plant. In the last ten years the improvement in efficiency in steam generating stations has been about 40 to 44 per cent., and it is estimated that over 8 million tons more coal would be required to generate the output of 20,000 million units sold in 1935 at the lower efficiency, than has been required at the higher efficiency now gained, equivalent to a difference in cost in that year of over £7,000,000. The average improvement has therefore been about £700,000 per annum, and if the researches are credited with only 10 per cent. of this gain, the annual advance alone exceeds the total annual expenditure of the Association on all its researches.

Investigations are being undertaken to develop methods for the detection of incipient breakdowns in electrical insulators, the object being to develop a means which will enable weak spots to be detected before breakdown occurs, thus avoiding interruptions to service.

Other Points from the Report

Over half a million clinical thermometers were tested at the National Physical Laboratory during

the year and 7,000 thermometers of other types. The Scientific Instrument Research Association has carried out on behalf of a member firm an investigation into the best form of "lensing" of clinical thermometers to enable them to be easily read.

Measurements with the noise measuring apparatus developed at the National Physical Laboratory have been made on motor vehicles on behalf of a Committee of the Ministry of Transport. Results have led the Committee to recommend that a noise level of 90 phons should not be exceeded by any new motor vehicle offered for sale or for use on the public highway. Measurements for the Home Office have been made of the loudness of certain portable sound-making instruments intended for use as local alarm signals in connection with air raid precautions. During the year the National Physical Laboratory verified the electrical measuring equipment used in testing a generator of 100,000 kilowatts, the largest installed in this country. The current involved was nearly 6,000 amperes and the accuracy attained in the tests was as high as in the measurement of smaller currents. The standard clock at the National Physical Laboratory has reached a stage at which its daily rate has been constant for a year within one-fiftieth to one-thirtythird of a second. A precision of one-thousandth of a second is attained for a week or ten days.

Tests in wind tunnels suggest that with aeroplanes flying at a speed considerably below that of sound (800 miles per hour), a shock wave is likely to be developed which will exercise such a drag on the machine as to set an almost impassable limit to the speed of flight.

The trouble arising from the dust raised when coal is disturbed can be prevented by spraying the coal with small quantities of a suitable oil. It has been found that the process is applicable to British coal which, in some cases, can be treated at the pit head at a cost of about 6d per ton and would then be dust-proof for comparatively long periods.

The complete gasification of coal in water-gas plants in which steam is passed over the heated coal is being studied at the Fuel Research Station. The method has proved successful with low volatile South Wales coal and yields a mixture of gases from which motor spirits can be synthesized. The method also provides a means of conserving valuable coking coals, the supply of which is limited.

The Building Research Station is now taking up the problem of ventilation of buildings and methods and instruments have been developed which will be first used in carrying out ventilation surveys in existing buildings. The extent to which a wall admits or excludes heat and therefore its effect upon the amount of heat required to keep the room warm is being investigated, for different types of wall, in six chambers of 8 ft. cube placed side by side with one wall of each facing north. Tests are being made first with three 9 in. solid walls and three cavity walls all of Fletton bricks arranged alternatively.

Synthetic resins have been produced which have the property of removing small quantities of materials from water passed through them. The possibilities of using these resins for the removal of boron and fluorine from natural waters is under investigation. Boron, the report states, to the extent of a few parts per million in water used for irrigation is detrimental to the growth of certain crops. With regard to fluorine, recent surveys in different parts of the world have indicated that fluorine in drinking water to the extent of one part per million causes the dental defect known as mottled enamel.

A machine has been developed by the Flour Millers Research Association for measuring and recording graphically the baking qualities of flour. A precise picture of the way the dough behaves at all stages of fermentation, including the effects of a baker's manipulation may be obtained with this instrument.

Experiments carried out in connection with lubrication research indicated that polishing is not due to mechanical abrasion but to a high temperature softening or melting of the solid which is smeared over the surface and quickly solidifies.*

* Summary of the annual report of the Department of Scientific and Industrial Research for the year 1936-37. Published by H. M. Stationery Office.

Development of Irrigation Research Institute, Lahore

N. K. Bose
Officiating Director, Irrigation Research Institute, Lahore.

[*In view of the discussions going on in the country regarding the desirability of opening River Physics Laboratories, the following account of the circumstances which led the Punjab Government to develop its River Physics Laboratories will prove interesting. Dr N. K. Bose is the present officiating director of the laboratory.- Ed., Sc. & Cul.*].

In every country where perennial irrigation has been applied to lands that used to receive no artificial irrigation or only inundation irrigation previously, deterioration of land due to rise of salts to the surface or due to waterlogging has set in (land which has been giving good crops and bringing a good return to the cultivator becomes Usar *i.e.*, laden with white deposits of alkalies;—in other cases, they become marshy). Punjab has been no exception to this. Shortly after canals were opened, indication of waterlogging and thur appeared on the surface. The evil of waterlogging went on spreading and became very serious in 1925. There were complaints from the public and from the civil authorities. Several meetings and conferences of civil and irrigation officers were held to discuss the situation and devise methods of overcoming the trouble. A Waterlogging Enquiry Committee consisting of one engineer, one scientist, and one revenue officer was ultimately appointed by the Government to prepare an estimate of the area damaged, investigate the causes and advise the Government on the most suitable measures to be adopted to arrest further rise of the water-table. This Committee formed the nucleus of the present Irrigation Research Institute.

The scientific member of the Committee instituted a series of investigations on the causes of the rise of the water-table and also on the immediate effect of this rise on the soil and the agricultural practice of the land.

It is well known that the causes that produce the rise in the water table and bring about waterlogging can be traced ultimately to seepage from rainfall and irrigation, or seepage from higher reaches or submontane districts or from rivers in certain months of the year. No quantitative data are available about the quantity of seepages from submontane districts or from rivers. In order to devise remedial measures to stop this rise in the water-table and to prevent land from going to waste due to waterlogging, a statistical analysis was carried out to find the relative importance of the seepage factors from rainfall and irrigation in affecting the water-table. One of the theories to account for waterlogging was the presence of an underground rock-ridge which extends from the Salt Range near Khusab on the Jhelum through Sargodha where there are a number of *outcrops* (*i.e.*, rocks exposed on the surface) named Kiranas, then through Chiniot where the river Chenab passes through a gorge, and then near Sangla and Shahkot where again this rock-ridge disappears to reappear near Delhi. The presence of these outcrops indicates that this ridge cannot be at any great depth and can, therefore, hold up the flow of the subsoil water. A Torsion Balance Survey* was carried out during the winters of 1927, '28 and '29 to find the position of this rock-ridge and its probable bearing on the waterlogging problem.

* The Torsion Balance is a very sensitive instrument invented by the famous Hungarian scientist Baron von Eötvös. It enables one to find very small variations in gravity round about a place. It is very largely used in seismology, and in geological prospecting to locate the existence of hidden masses of rocks or minerals.

DEVELOPMENT OF IRRIGATION RESEARCH INSTITUTE, LAHORE

This survey has shown that there is a rock-ridge below the alluvial soil of the Punjab at no great depth running from the Salt Range through the Chaj (the land between the Chenab and Jhelum) and the Rechna (the land between the Ravi and Chenab) Doabs most probably connecting with the Precambrian rock system of the Aravali Range that ends at Delhi. It has been found the water-table between this rock-ridge and the foothills of the Himalaya Range has risen very rapidly since the introduction of the canals in the Punjab. This supports the view that the subsoil drainage is held up by this rock-ridge not allowing free flow to the seepage water. Recently Col. Glennie of the Survey of India, has added further information regarding this ridge and its probable effect.

In order to find the exact mechanism how the seepage water from the natural surface reaches the subsoil water-table, mathematical treatment of the subject of subsoil flow of water was also started at the same time. This has led to a very important development for the design of weirs on sand foundation. In India weirs are frequently built to head up supply on the sandy beds of rivers. These weirs are specially built masonry dams in sand foundation, so that when the river is headed up to supply the canal system, the difference in water levels on the upstream and downstream side of the weir may be some times 20 to 25 feet. Due to this difference in head, water from the upstream side of the weir percolates through the sandy foundation, transmitting pressure as it flows on the underside of the masonry structure tending to lift it up. This has a tendency to make the weir unstable. Moreover, if the fall of pressure along the line of flow in the foundation sand be very rapid, finer particles of sand will be washed away by the high velocity of flow leaving cavities below the weir structures and endangering their very existence. Weirs and Falls form an important link in the canal system of the Punjab. Their safety is a matter of vital importance to the agricultural population and to the Revenue Department of the Province. Hence this subject of flow of water in a porous medium such as sand was first investigated theoretically, which showed that the movement of water in porous medium is similar to the flow of electricity. After that, *models of hydraulic structures* such as floors, weirs and falls were constructed in tanks containing sand in the Hydraulic Laboratory. Later, in the Physics Laboratory it was shown that the laws of flow of water in sand derived in the Hydraulic Laboratory were identical with those governing the flow of electricity. This confirmation of the theoretical deductions placed a powerful tool in the hands of those investigating the subject. Models of weirs and hydraulic structures made of non-conductors were now made in trays, and instead of the flow of water, the flow of electricity under these models was studied. Results were rapidly and accurately produced. The theoretical investigations were then further verified by model experiments suggested in consultation with an engineer officer and complete rules governing the safe design of weirs on sand foundations have now been formulated. This shows the results to be obtained by the scientist and the engineer working in collaboration.* The reconditioning of Marala Weir in the Punjab and of the Damodar (Anderson) Weir in Bengal have been based on these results. The Trimmu Weir, in connection with the Haveli Project- a project for irrigating several hundred thousand acres of arid land near the junction of the Chenab and Jhelum in the Punjab--is being designed to conform to the rules which have been laid down. It is confidently expected that weirs designed to the new principles will not be subject to the expensive failures which have occurred in the past.

As it has been pointed out before, seepage from canals is one of the factors responsible for water-logging and its prevention has been under investigation for some time. The process involves the treatment of the soil forming the bed of the canal with sodium carbonate. It has been found in the Laboratory that the treated soil becomes impermeable and consequently the seepage which takes place through the bed will be reduced. This treatment of soil can also be applied to the manufacture of bricks. It has been found that

* It may not be out of place to remark here that the credit of this achievement goes to Mr. A. N. Khosla, engineer, Dr. N. K. Bose, and Dr. Mackenzie-Taylor.

bricks made from soil treated with sodium carbonate are harder and less porous than those normally produced. This may lead to important economies in the construction of masonry works and increases considerably the life of the bricks in salt-affected areas.

Reclamation of Thur land has been one of the most important lines of work carried out by the Institute since it was started. The prevention of deterioration of good soils and the reclamation of deteriorated soils have been intensively studied. One of the first points to be settled was what constituted the first signs of deterioration in a soil. This question was solved by examining an extensive series of soils giving various yields of the same crop and determining their character. From the information so accumulated it is now possible to detect deterioration in its early stages and prevent its increase. As a result of experimental work it is also possible now to determine the stage of deterioration, to suggest means for the reclamation of deteriorated soils and to state which soils have deteriorated to such an extent that their reclamation is not economically possible.

As the activities of the Institute developed it has been consulted on various other problems now directly connected with waterlogging but of very great importance to irrigation engineers in the province. One of the subjects that have frequently been referred to the Institute for experimentation is to devise methods for preventing scour * below falls. Hence model work in the Hydraulic Laboratory has also been developed to study the flow over weirs and falls. A heavy item in the maintenance of weirs and falls is the annual repairs necessary downstream of these structures due to the scouring action of the water. Staggered blocks have been designed which throw the jet of water doing the damage from the bottom to the surface. As a result the scour is considerably reduced, the weir is made much safer and the amount spent on annual repairs becomes small. In one instance of a large weir fitted with these blocks, the annual repairs amounting to an average of Rs. 72,000/- have been reduced to nothing for the past two years.

A further subject of considerable importance to which attention is being paid is the control of silt in canal systems. The success of a canal system from the engineer's point of view depends largely on the best method of controlling silt entry at the headworks. Very few canals are entirely free from troubles which cannot ultimately be traced to bed silt. The raising and setting back of banks, pitching, staking and bushing, silt clearances and remodelling of channels are all directly attributable to silt. Studies have been in progress for some time to determine the effect of silt on the shape and slope of a channel. The investigations have now reached a stage when the theoretical treatment of the results is in progress and it is hoped soon to formulate relationships between the size of the bed silt and other data which determine canal design. In addition to the determination of the relationship between silt and design, methods for the exclusion or ejection of harmful silt from a canal system have also been studied by means of models. The river, the head works and a portion of the canal are modelled and silt movement both into and in the canal are studied in the model. As a result it has been possible to design silt excluders and ejectors which work efficiently. In one instance, the silt ejector has ejected over 5 million cubic feet of harmful silt in a working season at no cost. If this silt had remained on the canal bed it would have cost Rs. 40,000/- to excavate, or other maintenance charges to deal with the trouble would have been increased.

Models of rivers for the investigation of training and protection works have also been studied in the laboratory and on a larger scale at Malikpur. Before the introduction of model work

* This term is used to denote the erosion of soil round the bases of stone or brick piers on which a bridge rests, or erosion in the soil below a weir. Scour is the great terror of river engineers. On account of scour in 1932, the Hardinge Bridge was endangered in 1932, and the Government of India had to spend crores of rupees to strengthen the piers. The 'Scour' is due to eddy motion which develops round an obstruction, which lifts the earth, or stone dressing round a pier, and carries them to a distance. If the Indian Government spent some money on researches in Scour problem when the Hardinge Bridge was constructed, several crores of rupees could be saved. *Ed.—Sc. & Cul.*

of this type, the design of training work was largely a matter of personal opinion. It is now possible to test various suggestions and improve upon them so that these expensive works can now be constructed with the knowledge that they will fulfil the purpose for which they are designed.

The above gives a summary of the various activities of the Irrigation Research Institute as at present constituted. Experiments are mostly conducted under the following sections—Land Reclamation, Chemical, Physical, Hydraulics, Mathematical, Statistical and General. Besides these there is a River Model Station at Malikpur where big sized models are investigated, and moreover at all the headworks in the Punjab there are laboratories dealing with silt entry into the canal. To investigate the movement of silt and regime of canals a squad of overseers are stationed at various branches of the canal system.

It will be seen that the Research Institute as at present constituted with its various activities in the laboratories and the field forms a most unique institution of its kind in the whole world, and the record of its achievements in the past decade of its existence justifies the faith reposed in it by the Government and the public.*

* A Broadcast Talk from the All-India Radio Station, Lahore, on the 28th of February 1938.

Hindu Mathematics

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Introduction

LITTLE is known regarding the magnitude of the debt that mathematics owes to the genius of the Hindus.[1] It is, however, generally admitted that the basis on which our present-day mathematics has been built up was transmitted to Europe by the Arabs, who in their turn had acquired their knowledge from India and Greece. But what was the state of mathematical knowledge in India had not been comprehensively set forth until quite recently.[2] In the following an attempt is made to give in brief, avoiding controversial matter, an account of some of the main mathematical achievements of the Hindus.

Method

For a true understanding of these achievements it is necessary that the reader should have some understanding of the Hindu mind—the methodology and philosophy it worked out for itself. The Hindus aimed at perfection and generality and to achieve these they appear to have relied more on intuition than on deductive and empirical methods. This attitude of the Hindu mind is evident in their scientific literature in general and their mathematical works in particular. In arithmetic the Hindu authors contented themselves with giving only the rules and formulae for solving problems, without attempting to give demonstrations or proofs. In geometry they possessed most of the important theorems relating to the properties of triangles, quadrilaterals and circles, but they never attempted a logical exposition of the subject as the Greeks did. In their algebra, however, the formulae are in general

[1]The term Hindu means the inhabitant of India and has nothing to do with religion.

[2]The reader will find a detailed account of the mathematical achievements of the Hindus in Datta and Singh, *History of Hindu Mathematics*, Parts I (1935), II (1937) and III (to appear shortly), published by Motilal Banarasi Das, Lahore.

followed by demonstrations. Thus the statement made by some that the Hindus never gave any proofs of results is untrue. The absence of proofs in the Hindu works on *Pâṭîgaṇita* (arithmetic and mensuration) is partly justified by our arithmetics of today which do not give logical proofs for the validity of the various rules and processes of arithmetic. It is possible to write an arithmetic which would be as logically perfect as, say, the Elements of Euclid, but such an exposition would be utterly unsuited for use in our schools.

Of the Hindu Ramanujan, the greatest mathematician of modern times, it is said that he found out results by some sort of intuition that he had the peculiar gift of *seeing* them. He wrote down all these results and supplied proofs of some. It may be that the great Hindu mathematicians of bygone ages *saw* the results, but at the same time it must be admitted that they could and did supply the proofs of those results. Although logic is one of the most important of the tools for arriving at the truth, it is not the only one.

Arithmetic: Numeral Notation

Ten has formed the basis of numeration in India from the earliest known times. In fact, there is absolutely no trace of the extensive use of any other base of numeration in the whole of Sanskrit literature. It is also characteristic of India that there should be found at a very early date long series of number names for very high numerals. While the Greeks had no terminology for denominations above the *myriad* (10^4) and the Romans above the *mille* (10^3), the ancient Hindus dealt freely with no less than eighteen denominations. In the *Lalitavistara*, a Buddhist work of the first century, we find a list of denominations enough to count up to 10^{53}. Later on this series was continued to count up to 10^{140}. The literature of the Hindus abounds in large numbers. The biggest number used is probably the period of time known as the *Śîrṣaprahelikâ*. This number is stated to be so large as to occupy 194 notational places. It is $(8{,}400{,}000)^{28}$. It was the early use of such big numbers that necessitated the coining of a series of denominational names increasing in geometrical progression by multiples of 10 or 100.

The importance of these number names cannot be exaggerated, for the decimal place-value notation, or its equivalent variations, the word-numeral notation or the alphabetic notation of the Hindus is the logical outcome of a series of number names proceeding by multiples of 10. For, instead of saying four thousands three hundreds two tens and one, one can say four—three—two—one (or one—two—three—four if the lower denomination is to be stated first). This is exactly what the Hindus did when they employed the word-numeral notation or the alphabetic notation. In the former notation 4321 was written as *candra-kara-râma-veda* (where *candra*=1, *kara*=2, *râma*=3, *veda*=4). In the alphabetic notation the same number was written as *ka-ra-ba-va* (or *va-ba-ra-ka*) where *ka*=1, *ra*=2, *ba*=3 and *va*=4. Instances of the use of the word-numeral notation are found in the fourth century, while the alphabetic notation can be definitely traced back to the fifth century.

Numerical signs are probably as old as writing itself. Special signs for all denominations (units, tens, hundreds, thousands, etc.) were devised and used for the writing of numbers before the invention of the zero and the place-value principle. The invention of the zero [illegible] the use of the place-value principle have grea[illegible]cilitated the writing of numbers and as such [illegible]sponsible for the development of math[illegible]. These may be classed with the greatest [illegible] most useful inventions that the human race has made. The claim of the Hindus for the invention of the zero and the place-value principle, so far as the decimal system is concerned, is beyond question.

This notation which has been adopted by the whole of the civilized world was perfected in India about the beginning of the Christian era. The symbol *śûnya* ("zero") occurs in the Piṅgala *Chandah Sûtra*, a work belonging perhaps to the third century B.C. The *Bakhshali Manuscript* (c. 200), the *Sûrya-siddhânta*, the *Âryabhaṭîya* (499), the *Pañca-siddhântikâ* (505), and all later mathematical works use the place-value numerals. In fact, no mathematical works exist, which do not use these numerals. The earliest epigraphic use of the numerals is found in an inscription of 595 A. D. We find that by the middle of the seventh century these numerals had reached as far east as Cambodia where we find inscriptions dated

605, 606 and 608 of the Śaka era corresponding to 683, 684 and 686 A.D. In the West, the fame of these numerals appears to have reached Syria, for they are mentioned by the Syrian scholar, Severus Sebokht (*c.*650).[3]

Multiplication

The Hindus employed several methods of multiplication. Of these I shall mention two: (*i*) *Kapâṭa-sandhi* method and (*ii*) *sthâna-khaṇḍa* method. (*i*) In the *Kapâṭa-sandhi* ("door-junction") method the multiplicand and the multiplier are arranged as in the junction of a door and the method proceeds as below:

Ex. To multiply 135 by 12.

The numbers are placed as $\begin{matrix} \ \ 12 \\ 135 \end{matrix}$

Multiplying 12 by 5 and setting down the result below we have $\begin{matrix} \ \ \ 12 \\ 1360 \end{matrix}$

The multiplier is moved one place to the left, thus $\begin{matrix} \ 12 \\ 1360 \end{matrix}$

Multiplying by 3, adding the result and then moving the multiplier we have $\begin{matrix} 12 \\ 1420 \end{matrix}$

Then, after multiplication by 1 and addition as before, we have 1620 as the result.

This method was performed on a *pâṭî* ("wooden-board") by means of a piece of chalk, and figures were rubbed out and new ones substituted in their places as the work proceeded.

There were several variations of this method. In Arabia the method occurs in the works of Al Khowârizmî (825), Al Nasavî (1025), Al Hassâr (1175) and several others. It was called by Al Nasavî "tarik al-hindi" (the method of the Hindus). In Europe it occurs in the works of Maximus Planudes."[4]

(*ii*) The *sthâna-khaṇḍa* method is the same as our present method. Bhâskara II (1150) describes it thus:

"Multiply separately by the places of figures and add together."

The method occurs in all the Hindu mathematical works from Brahmagupta (628) onwards.

[3]Datta and Singh: *History of Hindu Mathematics 1* (1935) Chapter i.

[4]See Datta and Singh, *l.c.* pp. 143f.

Division

The modern method of long division is of Hindu origin. It occurs in all the treatises of the Hindus. Thus Śrîdhara (750) says:

"Having removed the common factor, if any, from the divisor and dividend, divide by the divisor the digits of the dividend one after another in the inverse order."

Extraction of Roots

Methods of extracting square and cube roots are found in the *Âryabhaṭîa* (499) and all later works. Our modern methods are contractions of *Âryabhaṭa's* methods.[5] The Hindu methods travelled to Europe through Arabia and occur precisely in the same form in the works of Peurbach (1423-1461), Chuquet (1448), La Roche (1520), Cataneo (1546), and others.

The Rule of Three

The Rule of Three owes its origin to the Hindus. In India it was called *trairâśika*, which translated literally means "three terms." Thus the name of the method in the European languages is a translation of the Sanskrit name. The rule was stated by Âryabhaṭa I (499) as follows:

"In the Rule of Three the *phala* ("fruit") being multiplied by the *icchā* ("requisition") is divided by the *pramana* ("argument")".

All other Hindu writers use the same terminology and state the rule in similar words. Âryabhaṭa II (950) uses a different terminology. He says:

"The first term is called *māna*, the middle term *vinimaya* and the last one *icchā*. The first and the last are of the same denomination. The last multiplied by the middle and divided by the first gives the result."[5]

With the above may be compared the following statement of the method given by Digges (1572), an English writer:

"Works by the rule ensueing ;;;. . . Multiplie the last number by the second and divide the product by the first number".... "In the placing of these numbers this must be observed that the first and third be of one denomination."

[5]*Ibid*, p. 205.

Problems[6]

Many of the problems of our present arithmetic are of Hindu origin. I shall quote two typical problems whose solutions were given by Brahmagupta (628) :

(1) In what time will a given sum s, the interest on which for t months is r, become k times itself ?

(2) In what time will four fountains, being let loose together, fill a cistern which they would severally fill in a day, in half a day, in a quarter and in a fifth part of a day ?

Algebra

It is generally admitted that the science of algebra owes its origin to the Hindus. In this science the Hindus made remarkable progress at a very early date. The essence of algebra consists in the use of symbols, *i.e.*, the letters of the alphabet to denote unknown quantities, just as the essence of our arithmetic is the place-value notation. The Hindus were the first to make systematic use of letters of the alphabet in their algebra. For this purpose they used the Sanskrit letters *ya, ka, ni*, etc. This use can be definitely traced back to the fifth century.

Name

Brahmagupta (628) called algebra *kuttaka ganita* or simply *kuttaka*. The term *kuttaka* meaning " pulveriser " refers to a branch of algebra dealing particularly with the subject of indeterminate equations of the first degree. It is interesting to find that this subject was considered so important by the ancient Hindus that the whole science was named after it. Prthûdakasvâmî (950) uses the term *bîjaganita* for algebra. *Bîja* means "element" and also " analysis " and *ganita* means " the science of calculation." Hence *bîjaganita* literally means " the science of calculation with elements " as opposed to numerical calculation, or "the science of analytical calculation." All later writers use the term *bîjaganita*. Sometimes algebra was called by the name *avyakta-ganita, i.e.*, " the science of calculation by the unknown."

Determinate Equations

Brahmagupta used the terms *sama-karana, samîkarana* (" making equal ') or more simply *sama* (" equation ") for equations. It thus appears that our present term equation is a translation of the Hindu term.

The geometrical solution of a linear equation in one unknown is found in the *Śulba sûtras* of Baudhâyana (c.800 B. C.) A number of linear equations are found in the *Bakhshali Manuscript*. They are solved by the method of " false position." In the works of later Hindu mathematicians beginning from that of Âryabhata I (499), the solution is algebraic. It may be mentioned here that the rule of "false position " does not occur in Hindu algebra, as the Hindus possessed a well developed algebraic symbolism at a very early date.

The *Bakhshali Manuscript* as well as later treatises contain linear equations of the form

$$x_1 + x_2 = a_1;\ x_2 + x_3 = a_2;\ \ldots\ldots x_n + x_{n+1} = a_n,$$

which seems to have been very popular.

Quadratic Equations

In the *Śulba sûtras* we come across the quadratic equation

$$7x^2 + \tfrac{1}{2}x = 7\tfrac{1}{2} + m$$

with its approximate solution given by Kâtyâyana[7] as $x^2 = 1 + \frac{m}{7}$

The general solution of the simple quadratic equation

$$4h^2 - 4dh = -c^2$$

is found in the early Jaina canonical works (500—300 B. C.), and also in the *Tatvârthâdhigama sûtra*[8] (c. 150 B.C.), as

$$h = \tfrac{1}{2}(d - \sqrt{d^2 - c^2}).$$

A formula for determining the number of terms of an arithmetic series whose first term

[6]For references see Datta and Singh, *l.c.*, p. 222 and p. 234.

[7]Datta, *The Science of the S'ulba*, Calcutta, 1932, p. 166.

[8]Datta, *Quellen und Studien zur Ges. d. Math.* 1931, pp. 245-54.

(a), common difference (b) and sum (s) are known, is found in all the mathematical treatises. The *Bakhshali Manuscript*[9] gives the solution as

$$n = \frac{\sqrt{8bs + (2a-b)^2} - (2a-b)}{2b}$$

Âryabhata I (499) gives the result in the form

$$n = \frac{\sqrt{8bs + (2a-b)^2} - 2a}{2b} + 1/2$$

Brahmagupta (628) states the solution of the equation

$$ax^2 + bx = c$$

as follows:

"The quadratic: the absolute quantity multiplied by four times the coefficient of the square of the unknown is increased by the square of the coefficient of the middle (*i. e.*, x); the square-root of the result being diminished by the coefficient of the middle and divided by twice the coefficient of the square of the unknown, is (the value of) the middle (*i. e.*, x)"[10]

The method by which the above result is obtained was explained by Śrîdhara (750) thus:

"Multiply both the sides (of the equation) by a known quantity equal to four times the coefficient of the square of the unknown; add to both sides a known quantity equal to the square of the coefficient of the unknown; then (extract) the square root".

Writing the equation as

$$ax^2 + bx = c,$$

we have

$$4a^2x^2 + 4abx = 4ac,$$

or $$(2ax + b)^2 = 4ac + b^2.$$

Therefore $$2ax + b = \pm\sqrt{4ac + b^2}$$

giving $$x = \pm\sqrt{4ac + b^2} - b$$

The original treatise of Śrîdhara in which the above rule occurs is lost. The rule is, however, preserved in quotations by Bhâskara II, by Jñânarâja and by Sûryadâsa. It is difficult to say whether Śrîdhara used both the signs of the radical or not. There is, however, definite evidence of the use of both the signs of the radical by Mahâvîra[11] (850), who gives the solution of the equation

$$(a/b)x^2 - x + c = 0$$

$$x = \frac{b/a \pm \sqrt{(b/a - 4c)b/a}}{2}$$

Various problems involving simultaneous quadratic equations of the following forms are found in the works of Hindu mathematicians;

(*i*) $x - y = d$, $xy = b$ (*ii*) $x + y = a$, $xy = b$

(*iii*) $x^2 + y^2 = c$, $xy = b$ (*iv*) $x^2 + y^2 = c$, $x + y = a$

Âryabhata I (499) gives (*i*) and (*iv*), Brahmagupta (628) gives (*i*), (*iii*) and (*iv*), and Mahâvîra (850) gives all of them. These equations are also found in the works of later writers.

The equations

$$x^2 + y^2 = m \qquad x^2 - y^2 = m$$
$$x - y = n \qquad x + y = p$$

were given great prominence by all Hindu mathematicians. Brahmagupta gives to the process the name *viṣama karaṇa*.

Indeterminate Equations of First Degree

The earliest Hindu algebraist to treat of indeterminate equations of the first degree, as far as we know, was Âryabhata I (499). He gave a method for finding the general solution in positive integers of the simple indeterminate equation

$$by - ax = c$$

for integral values of a, b, c and further indicated how to extend his method to get positive integral solutions of simultaneous indeterminate equations of the first degree. Bhâskara I (522) showed that the same method might be applied to solve $by - ax = -c$ and further that the solution of this equation would follow from that of $by - ax = -1$. Brahmagupta and later writers simply adopted

[9] Folio 65 verso, continued on folios 64 recto and 56 recto and verso.

[10] *Brahma-sphuta-siddhanta* of Brahmagupta ed. by Dvivedi, Benares, 1902, xii. 15.

[11] *Ganita-sara-samgraha* of Mahâvira, iv. 59. Also iv. 57; iv. 61-4.

the methods of Âryabhata I and Bhâskara I. About the middle of the tenth century Âryabhata II[12] improved them by pointing out how the operations can in certain cases be abridged considerably. He also noticed the cases of failure with respect to the equation of the form $bx - ay = \pm c$. These results reappear in the works of later writers.

Problems for whose solution the ancient Hindus investigated indeterminate equations of the first degree may be classified into three varieties. The problem of one variety is: to find a number (N) such that, if a, b, R_1 and R_2 are given,

$$N = ax + R_1 = by + R_2$$

Hence $\quad ax - by = (R_2 - R_1)$

or $\quad ax - by = c,$

where $c = R_2 - R_1$. In a problem of the second kind we are required to find a number x such that its product with a given number α being increased or decreased by another number γ and then divided by a third number β will leave no remainder. In other words we shall have to solve

$$\frac{\alpha x \pm \gamma}{\beta} = y$$

in positive integers. The third variety of problems lead to equations of the form

$$ax + by = \pm c$$

The particular case $ax - by = \pm 1$ was given prominence and was considered separately by Bhâskara I, Brahmagupta and *Bhâskara II*, who showed how the solution in positive integers of the general equation $ax - by = \pm c$ could be derived from the particular case.

Rules for the solution of simultaneous indeterminate equations of the first degree are found in the works of Brahmagupta[13], Śrîpati[14] (1039) and Bhâskara II[15] (1150). Such equations are furnished by problems of the following type:—

(1) "(Four merchants) who have horses 5, 3, 6 and 8 respectively, camels 2, 7, 4 and 1; mules 8, 2, 1 and 3, and oxen 7, 1, 2 and 1 in number, are all owners of equal wealth. Tell me instantly the price of the horses,[16] etc.

(2) Find a number N which when severally divided by $a_1, a_2, \ldots, a_n$ leaves remainders $B_1, B_2, \ldots, B_n$ respectively.

Indeterminate Equations of Second Degree

The equations

$$Nx^2 + c = y^2,$$

and $$Nx^2 + 1 = y^2$$

were considered by Brahmagupta (628) who established the following lemmas to obtain their general solutions in integers:—

(*i*) If $x = a$, $y = B$ be a solution of the equation

$$Nx^2 + k = y^2,$$

and $x = a'$, $y = B'$ be a solution of the

$$Nx^2 + k' = y^2$$

and $x = aB' \pm a'B$, $y = BB' \pm Naa'$ is a solution of the equation

$$Nx^2 + kk' = y^2.$$

In other words, if

$$Na^2 + k = B^2$$

and $$Na'^2 + k' = B'^2$$

then $$N(aB' \pm a'B)^2 + kk' = (BB' \pm Naa')^2$$

(*ii*) If $x = a$, $y = B$ be a solution of

$$Nx^2 + k = y^2$$

then $x = 2aB$, $y = B^2 + Na^2$ is a solution of

$$Nx^2 + k^2 = y^2$$

(*iii*) If $x = a$, $y = B$ be a solution of

$$Nx^2 + k^2 = y^2$$

then $x = a/k$, $y = B/k$ is a solution of

$$Nx^2 + 1 = y^2$$

The above lemmas were rediscovered in Europe by Euler in 1764 and by Lagrange in 1768.

Brahmagupta's method for solving $Nx^2 + 1 = y^2$ consists in obtaining empirically a, k and B, such that

$$Na^2 \pm k = B^2,$$

and then using his lemmas to get the general solution of $Nx^2 + 1 = y^2$.

[12] For details see Datta and Singh, *l.c.*, Pt. II.

[13] *Brahma sphuta-siddhanta*, xviii. 51.

[14] *Siddhanta Sekhara*, xiv. 15-16.

[15] *Bijaganita* of Bhâskara II ed. by S. Dvivedi and revised by Muralidhara.

[16] Jha, Benares, 1927, p. 76.

Śrīpati[17] (1039) seems to have been the first to give the solutions

$$x = \frac{2m}{m^2 \sim N}, \qquad y = \frac{m^2 + N}{m^2 \sim N}$$

where m is any rational number. This appears in the works of later Hindu mathematicians. This solution was rediscovered in Europe by Brouncker (1657).

To obtain solutions in positive integers Brahmagupta uses the auxiliary equation $Na^2 + 4 = B^2$, and obtains

$$x = \tfrac{1}{2}aB\ (B^2 + 3)\ (B^2 + 1),$$
$$y = (B^2 + 2)\ \{\tfrac{1}{2}\ (B^2 + 3)\ (B^2 + 1) - 1\}$$

Putting $p = aB$, and $q = B^2 + 2$, we can write

$$x = \tfrac{1}{2}p\ (q^2 - 1)$$
$$y = \tfrac{1}{2}q\ (q^2 - 3)$$

This solution was rediscovered by Euler.

Śrīpati[18] expressly observes that if $k = -1, \pm 2$, or ± 4, the roots obtained by Brahmagupta's method are integral, but no method seems to have been known to him for finding a root of

$$Na \pm k = B^2$$

k having one of the above values. Bhâskara II (1150) however, succeeded in evolving a simple method of getting two integral solutions of the above. This method is called by him *cakravâla* ("the cyclic method"). Thus Bhâskara II succeeded in solving

$$Nx^2 \pm c = y^2$$

completely.

[17] *Siddhanta Sekhara*, xiv, 33.
[18] *Ibid.* xiv, 32.

Bhâskara II also succeeded in obtaining the general solutions of the following equations:—

(*i*) $ax^2 + bx + c = y^2$,

(*ii*) $ax^2 + bx + c = ay^2 + By + D$,

(*iii*) $ax^2 + by^2 + c = z^2$,

(*iv*) $ax^2 + bxy + cy^2 = z^2$.

There are many other types of equations that occur in the works of Bhâskara II. These cannot be mentioned here. But before I conclude this topic I wish to point out that Bhâskara II obtained the solution of the double equation

$$ax^2 + by^2 + c = u^2$$
$$ax^2 + By^2 + d = v^2$$

Bhâskara takes the example

$$x^2 + y^2 - 1 = u^2$$
$$x^2 - y^2 - 1 = v^2$$

and gives its solution as

$$x = \frac{(4m^4 + n^4) + r^2}{(4m^4 + n^4) - r^2}, \qquad u = \frac{2r(2m^2 + n^2)}{(4m^4 + n^4) - r^2}$$

$$y = \frac{4mnr}{(4m^4 + n^4) - r^2}, \qquad v = \frac{2r(m^2 - n^2)}{(4m^4 + n^4) - r^2}$$

where m, n and r are any rational numbers.

A particular case of the above solution, for $r = s/t$, was obtained by Genocchi[19] (1851). Another particular case was solved by E. Clere[20] (1850). A third easily deducible solution was given by Drummond[21] in 1902.

[19] *Nouv. Ann. Math.* *10*, 80-85, 1851.
[20] *Nouv. Ann. Math.* *9*, 116-118, 1850.
[21] *Amer. Math. Monthly.* *9*, 232, 1902.

(*To be continued*).

The Milky Way and Beyond

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I AM going to talk to you about the oldest of the sciences. If the historians are right, the science of astronomy had its beginnings in the plains of Babylon (Chaldea). The knowledge in due time spread west to Greece and Europe, and east to India. Now East and West are meeting for the advancement of science, and our discussions range over a multitude of subjects, from the venerable science of the stars to the youngest and most recent of its progeny.

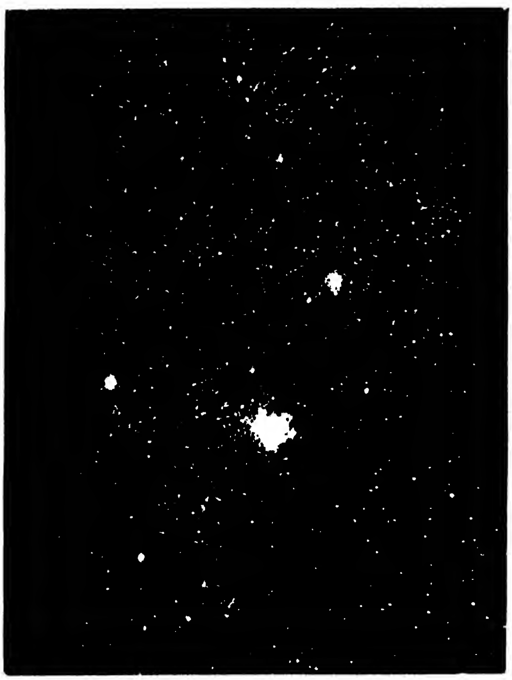

Fig. I.
A Section of the Milky Way.

In your clear sky, the stars are more brilliant and arresting than in the dim skies of my own island, and I think I may assume that you have all noticed, as one of the striking features of the night sky, the irregular band of misty light, which we call the Milky Way, forming an arch from horizon to horizon. Let us see what the telescope makes of it. (Fig. I).

This is a photograph of a bright patch of the Milky Way. You see that it is composed of multitudes of stars. I had almost said "Countless multitude," but it is the business of the astronomers to count them, and the number of the stars visible in the Milky Way is not uncount-

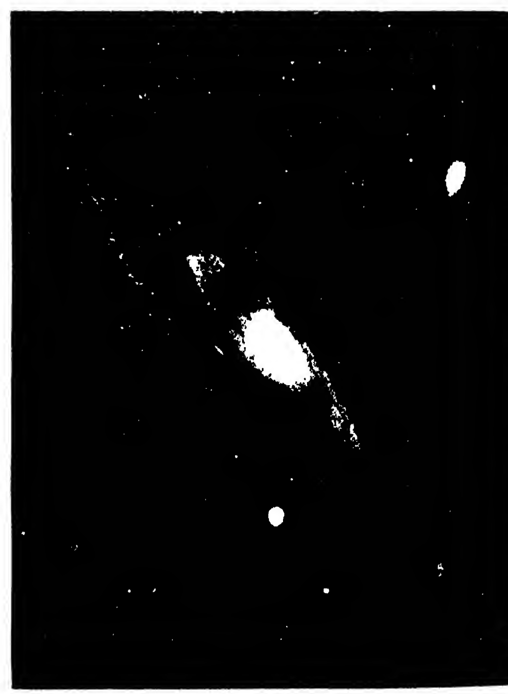

Fig. II.
The Great Spiral Nebula in Andromeda
(Mt. Wilson Solar Observatory)

able, though it runs into hundreds of millions. Each of these bright points is a star, that is to say, a body of the same general nature as our Sun.

We are looking at the Milky Way from inside—it forms a girdle around us. But let us, for a moment, imagine ourselves looking at it from the outside—looking at it from some point in the great ocean of space which envelopes us. If we could attain such a viewpoint we should see the Milky

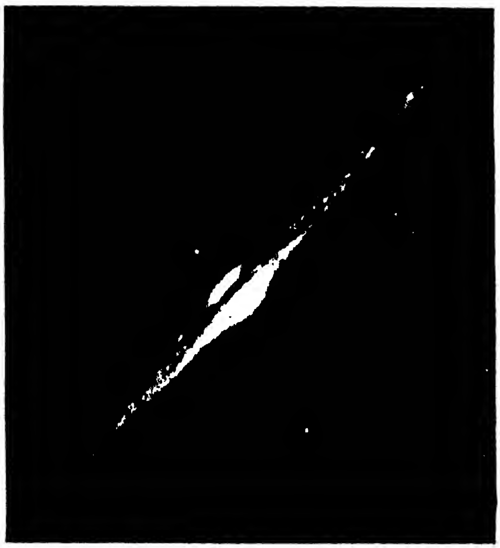

Fig. III.

Spiral Nebula on Edge N. G. C. 4565 (from *Sc. Month.* vol. 44, p. 31, 1937.)

Way like a little island of matter in an ocean of empty space—and we should see also that it was only one of many islands scattered thinly over space like an oasis in a desert of emptiness.

I am able to show you what these islands look like. (Fig. II).

This, of course, is not our own island but one of others, visible to us in the far distance, but we may take it that our own Milky Way system would look very similar if seen from outside. The spirals will correspond to the girdle of the Milky Way and our own position would be rather a long way from the centre. (Fig. III).

We call these great systems of stars *Galaxies.* For the present I shall speak only of the *Galaxy* to which we belong. It is a system numbering probably between 10,000 million and 100,000 million stars—say 20 stars apiece for every human being on the earth. That is not the whole universe, but it is enough to be going on with.

When we examine the stars individually we find a great diversity. The stars appear to us as having all sorts of degrees of brightness; that, of course, is partly because they are at different distances, but in addition to that, their actual intrinsic brilliance differs widely. Relatively the difference of luminosity between the brightest and the faintest stars we know is about the same as the difference between a lighthouse and a firefly. Some of them have a surface temperature as high as 20,000°C; others not more than 3,000°C. Some of them are pulsating, swelling up and deflating with a period of a few days or weeks, and their brightness changes as they expand or collapse; it is a good thing for us that our Sun does not behave that way. A great many of them go about in couples—two stars revolving round each other. However, the ***bachelor stars,*** like our Sun, are in the majority.

One star, we know, has a system of small cold globes—planets—revolving round it. I refer, of course, to our Sun. It is impossible with our present means of observation to find out whether any other star has a similar system of planets; so that we have only theoretical probabilities to guide us. It used to be taken for granted that all the other stars would have planets—that it was, so to speak, the main business of a star to give light and heat to attendant planets. But although our conclusions are still very uncertain we are now inclined to take the opposite view—that although a star with planets may occur here and there in the universe it is a comparatively rare development, and we should have to make a long search among the thousands of millions of stars in our galaxy before finding anything like the solar system. This is a view which we owe largely to Sir James Jeans. It is thought that the earth and the other planets are the result of a very rare accident. Some two thousand million years ago our Sun nearly came into collision with another star. There was no actual smash; the second star passed by and is now

far away. But as it passed it raised a great tidal wave which broke into jets of matter which have condensed to form the planets.

There is a lot of room in interstellar space; and notwithstanding the reckless speed of the stars, celestial traffic conditions are extremely safe. In the whole of its long life-time it is most unlikely that a star would collide, or have a close shave, as our Sun appears to have done. Our Sun was one of the few unlucky ones. And the accident provided among other things a small cool globe fit for habitation—where ultimately life of various kinds came into being—including astronomers who puzzle their brains as to how it all happened.

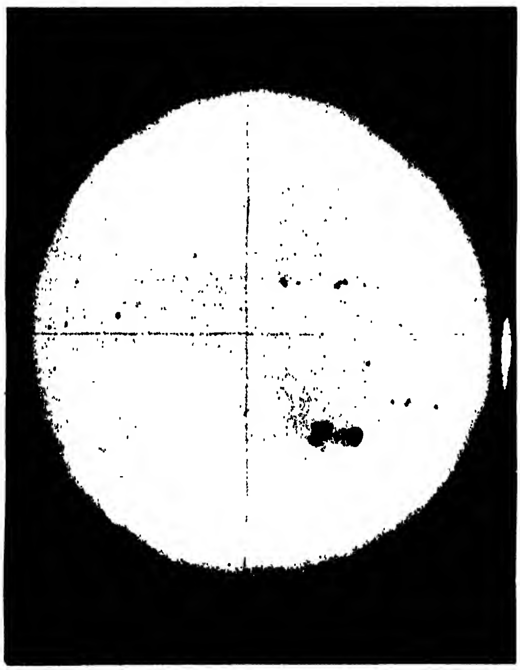

Fig. IV.

A Photograph of the Sun taken in 1893, Aug. 6. Mark the large sunspot on the S. E. quadrant. The area is more than 2500 millions of square miles.

I do not know whether this theory of the birth of the solar system is right; I state it as the view which now seems to be most widely held, but it is much more speculative than most of what I shall have to tell you. I suppose we all feel a special interest in any suggestion astronomy may offer as to man's place in the universe. As I have said, we used to think of each of the myriad points of light in the sky as a sun giving light and warmth to an attendant circle of planets. It seemed a presumption, bordering almost on impiety, to deny to them inhabitants of the same order of creation as ourselves. But we forget the prodigality of Nature. How many acorns are scattered for one that grows to an oak! If indeed the aim of all this evolution is to provide homes for beings like ourselves, it would be just like her methods to scatter a billion stars whereof haply two or three might achieve the purpose intended.

The Sun is the only star near enough to enable us to examine its surface in detail—so I will show one or two photographs of it. They will presumably give a general idea of the conditions in other stars; but as I have said the stars are very diverse and we must not assume that all stars would look just like these pictures. (Fig. IV & IV A).

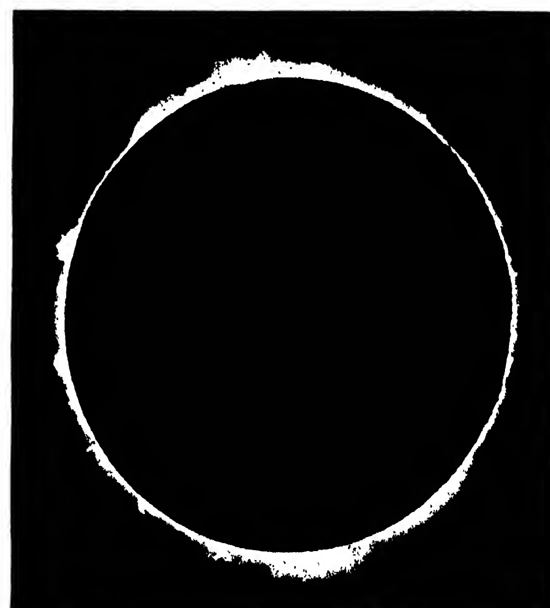

Fig. IVA.

A photograph of the Sun during the total solar eclipse of 1927—by the courtesy of the Astronomer Royal.

Ordinary photographs of the Sun are rather dull and uninteresting.

At the most they show one or more of these dark patches called sunspots. We learn a great deal more by using an instrument called the spectroheliograph which is blind to all light except that which comes from a particular source—a particular kind of atom. Here, for example, the instrument is set so that it shows only the light coming from hydrogen atoms. (Fig. V).

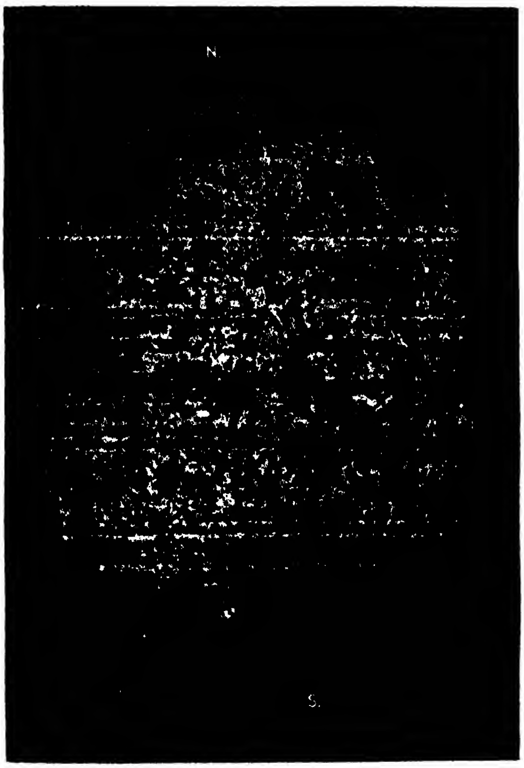

Fig. V.

Monochromatic Image of the Sun in *Hα*-light. Mark two solar disturbances with a spot at the centre. [Photograph due to G. E. Hale.]

The dark marking (at the centre) is a sunspot and you see that it is the centre of a whirlpool—or rather a whirlwind, because the level you are now looking at is high up in the Sun's atmosphere. There is another picture in the light of calcium this time—which shows us a lower level in the atmosphere. This photograph is one of those taken in India at the Kodaikanal observatory. (Fig. VI).)

Fig. VI.

Monochromatic Image of the Sun, taken at the Solar Observatory, KodaiKanal, India, on Aug. 10, 1917, in calcium *K* light. It shows the dark and bright flocculi of Ca^{+} at the time of sunspot maximum.

Time does not permit me to dwell longer on the surface conditions of the Sun and stars, which is nowadays a very active field of research, both theoretical and observational. I will say that most of the modern work on this subject has its origin in a paper published by Prof. Saha of Allahabad in 1921, which ranks as one of the classical papers of astrophysics. That first gave the key to the physical interpretation of the facts revealed by the spectroscope. It introduced a method of attack, which has been developed and extended by many theorists and has guided observational researches throughout the world.

Although the stars are diverse in many of their characteristics they are remarkably uniform in one respect, namely in mass, that is to say, in the amount of matter composing them. I do not mean that all stars have just the same mass or that the differences of mass are unimportant—but the range of mass is small considering their diversity in other respects. A range from a quarter to four times the Sun's mass would cover all but a few excep-

tional stars. On the other hand, the stars vary enormously in size, diameter and volume. Broadly speaking, a big star is big, not because it contains an exceptionally large amount of matter, but because it is puffed out like a balloon; and a small star is small because its material is highly compressed. The two extremes are specially interesting—the most rarefied and the most condensed stars. We find stars which are as rarefied as gas. Capella, for example, has an average density about the same as the air in a room. To be inside Capella would be like being surrounded by air as we ordinarily are except that the temperature which is about five million degrees Centrigade, would be noticeably different. Still more extreme are the red giant stars, Betelgeuse in Orion and Antares in the Scorpion. To picture Betelgeuse you must imagine the Sun swollen up until it has swallowed up Mercury, Venus and the Earth and extended beyond us nearly to the orbit of Mars.. Swollen out in this way the matter is extremely tenuous, and the only thing we can compare it with is the gas in an exhausted vessel like a vacuum tube. Betelgeuse is what we should ordinarily describe as a rather good vacuum. You see it is a matter of relativity—compared with the ordinary terrestrial standards Betelgeuse is a vacuum; but compared with the extreme emptiness of interstellar space which surrounds it, Betelgeuse is an important aggregation of matter—a star.

This is one of the reasons why the study of stars is important for the advancement of science generally. It is only recently that we have succeeded in producing in the laboratory a more highly exhausted vacuum than Betelgeuse. That refers to the average density of the whole star; the outer parts which we actually see are much more rarefied. In the outer parts of the Sun and other stars, in the gaseous nebulae of which I will show pictures later, we are observing matter a million times more rarefied than the highest vacuum obtainable on earth. Our astronomical observations, therefore, teach us not only about the Sun and stars and nebulae, but about the physics of matter in general, because we observe matter under conditions more extreme than a physical laboratory can reproduce. More and more today astronomy plays this part of extending the range of physical experiments. We wring from matter its secrets by subjecting it to extreme heat, extreme cold, high compression, high rarefaction, and so on. When the limits possible in a terrestrial laboratory have been reached we turn for more information to the laboratories in the heavens, where hotter furnaces and higher vacua are to be found, and a vaster scale of experiment is in progress.

I will turn now to the other extreme—the very dense stars. We find certain stars called white dwarfs whose material is far denser than the heaviest substance known on earth. I would like to say a little about the way in which we are led to realize this.

From our general knowledge of physics we can learn a great deal about the conditions deep down in the interior of a star although of course we cannot directly observe what is happening. Let us for definiteness take the Sun. The temperature which we actually observe—the surface temperature of the Sun—is about 6000°C; but that is only the marginal heat of the great furnace, and down below it is very much hotter. We find by a not very difficult calculation that the mean temperature in the interior of the Sun is about fourteen million degrees Centigrade. That sounds inconceivably hot. But from the point of view of theoretical physics, it is not really anything to get frightened at, and we can deal with it as we deal with the other big numbers which so often turn up in astronomy As a matter of fact the high temperature makes the problem of internal state of a star easier for us; it is the low temperature which introduces complications and baffles the theorists.

One of our chief aims in studying the inside of a star is to find out how its brightness depends on the mass and radius. An electrical engineer will tell you that to produce a certain amount of illumination you must have a generator of a certain size. In an analogous way we can calculate that a star, to produce a given output of light and heat, must have a certain size, and must contain a certain number of tons of matter. But just as the engineer, in order to make his calculations, must have a thorough understanding of what goes on

inside a dynamo, so the astronomer must have a thorough understanding of what goes on inside a star.

I was working on this problem between 1916 and 1924 and, in the end, I calculated what is known as the mass-luminousity relation— a formula which shows how the brightness of a star depends on its mass and radius. The mass is the main determining factor, the radius affects the result only to a small extent. But I must explain that this formula was only intended to apply to the rarefied stars that I spoke of, because it was limited to stars whose material could be regarded as a perefect gas. The theory of a gas is simpler than the theory of liquids and solids. One began naturally with stars whose densities showed that they must be gaseous.

When I came to this formula with the observed luminosities and masses of stars, the result was rather disconcerting. If the actual stars had disagreed with the formula well, it would not have been the first time that a theory had broken down under the test of observation. But that was not the trouble this time. The actual stars agreed with the formula very well. The trouble was that they would not stop agreeing. It was right that the diffuse stars should agree with the theory, but when one came to the dense stars, they ought to have shown an independent spirit and refused to be treated like a perfect gas. But the Sun wtih a mean density greater than that of water, and other stars with densities greater than those of iron and lead, all agreed with the formulae just as though they were composed of perfect gases.

When the stars themselves had called attention to this fact, it was not difficult to find the explanation. Why is it that we can compress air but cannot appreciably compress water? It is because in air the molecules are far apart with lots of empty space between them; when we compress air we are merely squeezing out some of the empty space. But when the molecules are placed close together, as they are in ordinary liquids and solids, there is no empty space to be squeezed out and the material becomes practically incompressible. In all substances the limit of compression is reached when the molecules or atoms jam together and cannot therefore be packed any closer. This limit corresponds roughly to the density of the solid or liquid state. We had been taking it for granted that the same limit would apply on the stars and on the earth. But we ought to have remembered that at the temperature of 14 million degrees in the interior of the Sun atoms are thoroughly smashed up—or ionized (to use the recognized term). An atom has a heavy central part or nucleus, surrounded by a widely extended but unsubstantial structure of electrons—a sort of crinoline. At the very high temperature inside a star, this crinoline is broken up and the electrons are scattered about all loose. If you are calculating how many people can be packed in a ballroom, it makes a difference whether the ladies are wearing crinolines or not. So, judging by the crinolined terrestrial atoms, we should reach the limit of compression at densities not much greater than the density of water; but uncrinolined stellar atoms can be packed much more densely, and do not jam until we reach densities far greater than the density of water, or indeed of any material met with on earth.

That then is the reason why stellar matter of the density of water and iron behaves in the way characteristic of matter far from the limit of compression. Such matter is indeed far from the limit of compression, which has been put even so much higher by the breaking up of the outer parts of the atom, and so really is a perfect gas; and stars of this density agree with the mass-luminosity relation calculated for a perfect gas. But that is not all. There is no longer any reason why stellar densities should stop at the density of iron and lead; and we might, if we searched, find densities transcending that of any thing hitherto imagined. That calls to mind the Companion of Sirius, a faint telescopic star close to the brilliant dog-star Sirius which revolves round it.

There is an indirect method of finding out the densities of stars which I cannot stop to explain. The method was tentative; and when it was found to give for the Companion of Sirius a density 50,000 times that of water, it was assumed that it must have gone wrong. But, according to what I have been saying, a density even 50,000 times greater than that of water is not at all impossible.

The method might not have failed and the huge density might be genuine. So astronomers set about applying another test which involves an application of Einstein's theory, and determines the density in another way altogether. This second method also gave the high density; so we may evidently accept it as genuine. The stuff of the Companion of Sirius is 2,000 times as dense as platinum the heaviest thing we know on earth. That means that matter on Sirius B weighs about a ton to the cubic inch. Imagine matter so heavy that it would need a powerful crane to lift apiece the size of a rupee.

Besides the stars we find in our galaxy great patches of luminous gas, called nebulae. (Fig. VII). These nebulae are of enormous extent enveloping a great number of stars. Some of these stars are actually in the midst of nebulae and it is the radiation of the stars which causes nebulae to shine. They do not reflect the star light; their light is a fluorescence. (Fig. VIII).

Fig. VII.

Planetary Nebula. N. G. C. 7662.—Lick Observatory photograph.

The matter in a nebula is very much rarefied. If we take out of this nebula a chunk as large as the earth, and compress it to ordinary density it would make just about a railway truck load: That is to say, the whole amount of matter contained in a volume of the size of the earth is of the order 10 or 20 tons.

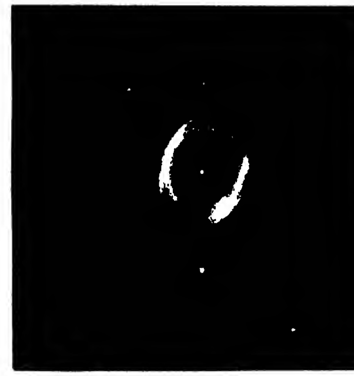

Fig. VIII.

Planetary Nebula. Ring Nebula in Lyra. The luminosity of this nebula is supposed to be due to fluorescence of outer shell of gas from light of a star inside.

When there are no hot stars in the neighbourhood to stimulate it to shine, the nebula remains dark and we see it only as a dark obscuring cloud blotting out everything behind it. (Fig. IX).

Let us look to the rest of the universe which lies beyond the Milky Way. Our system of stars is, as it were, just one island, in the Ocean of Space an oasis in a desert of emptiness. From this island, we can look out and see in the far distance other islands, in fact a whole archipelago of islands, one behind another till our vision fails. I have already shown you photographs of one or two of these external galaxies. Here is another. That is a system of some thousands of millions of stars like our own Milky Way system—which we see in the far distance. (Fig. X).

How many of these island galaxies are there? From actual count it is found that the number within reach of the largest telescope at present existing—the 100″ reflector at Mount Wilson—is about 50 millions. There must, of course, be many more too faint for us to see. Perhaps rather surprisingly we have a fair idea of what the total number must be. It is certainly not less than 10,000 millions, and may well be over 1,00,000

millions. A billion may be taken as the extreme upper limit. When we were considering the Milky

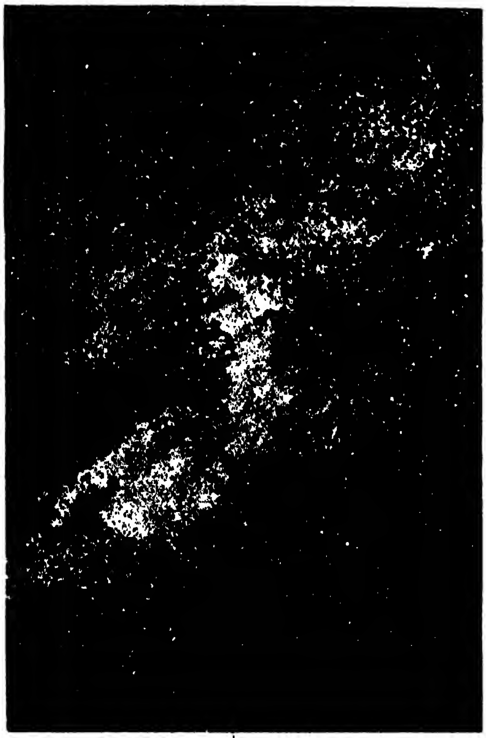

Fig. IX.
The America Nebula.

Way system only I said there were about 20 stars apiece for every inhabitant of the earth; now that we are considering the whole universe the allotment is more liberal—not 20 stars apiece, but 20 galaxies apiece for every one on earth.

Let us now see where we have got to in the scale of size:

1 light year	6, 000, 000, 000, 000 miles
Distance of the nearest star	26, 000, 000, 000, 000 miles
Distance of the remotest nebula so far measured	1500, 000, 000, 000, 000, 000, 000 miles

Now do not tell me that you cannot realize these big distances. Of course, you cannot. But that is the last thing one wants to do with big numbers—to realize them. Take this number for example, 26 billion. No one can realize a billion. But if you happened to be in Germany in 1923 when the bottom dropped out of the mark, when you were presented with a bill for a billion marks for your dinner, the problem was not to realize a billion but to pay it. The Chancellor of the Exchequer, when he presents his budget for 800 million pounds, cannot realize the amount of notes or other forms of wealth that this implies—but he can spend it. It is an altogether fallacious idea that these big numbers make a difficulty in comprehending astronomy; they can only do so if you are seeking a wrong sort of comprehension.

Fig. X.
The spiral N.G.C. 5194 5 (Messier 51-Mount Wilson Observatory.)

What I here want to call attention to is that now that we are going out beyond the Milky Way we have taken another big step up in the scale of distances and this last figure—the distances of one island-galaxy from another—will become our unit.

Naturally, we cannot find out very much about these remote objects, but, for the brighter ones at least, there are two things we can ascertain. We can determine the speeds with which they are moving either towards or away from us; and we can determine—or perhaps I should rather say—estimate the distances—well enough to give a rough idea of their distribution in space.

I may perhaps explain how the speeds are measured. (Fig. XI).

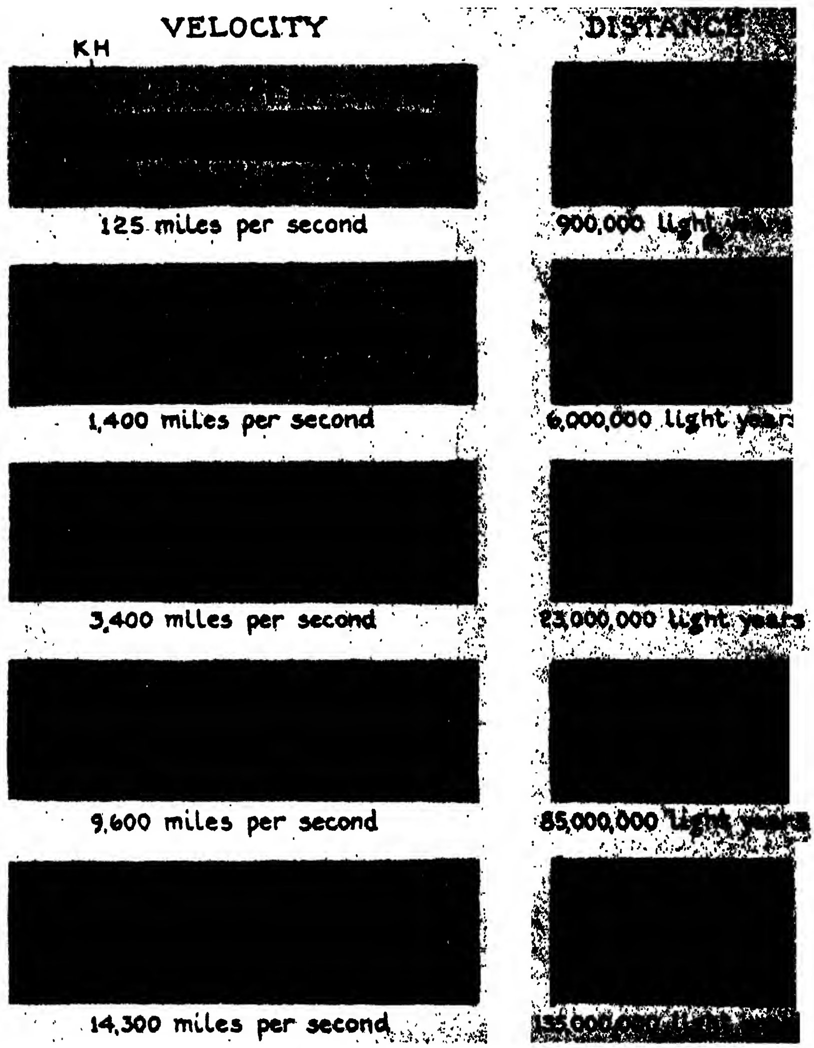

Fig. XI.

Method of determining velocity-distance relation for Extragalatic Nebula. These spectra and direct photographs were prepared by Hubble and Humason in the Mt. Wilson Observatory. In order of distance, we have N. G. C. 22, Virgo, Pisces, Ursa Major, and Gemini Clusters.

These are spectra of the nebulae. Now whether you are expert in spectra or whether you are not, I think, you will agree that they are bad spectra. They are not nice, clean spectra with sharp lines

across them like those of the stars. That is because the nebulae consist of multitudes of stars with all sorts of spectra which are here superposed. It is as if a composite photograph of the faces of the whole population of the earth was made; the result would be a blur in which you could just make out two eyes and a nose. Here you see a corresponding blur for the stars which form the nebulae and you can just make out—shall we say—two eyes and a nose—that is to say two features possessed by most of the stars. Actually these are the *H, K*-lines of calcium-dark lines, here shown bright because the picture is a negative. What we have to do is to measure just where they fall—you see how they shift along- these speeds are very large; indeed very much larger than we find in the stars of our own galaxy. The remarkable thing is firstly that (with two or three exceptions which can be accounted for) they are all running away from us, and secondly, the farther they are away, the faster they go. The speed is proportional to the distance: a nebula 1 million light-years away recedes at 100 miles a second, a nebula 50 million light-years away recedes at 5000 miles a second. This increase has been raced up to a distance of 250 million light-years, where we find a nebula receding at a speed of 25,000 miles a second. There for the moment we have to stop until a larger telescope is built, which will enable us to extend our measurements to still fainter and more remote nebulae.

This running away does not mean that they have a particular aversion to us. It means that the whole system of the galaxies is expanding. If a gas or any other substance expands uniformly, the distances between its particles increase. So if you imagine yourself sitting on one of the particles, all the other particles are increasing their distances from you so that they seem to be running away. But that will happen whatever particles you choose to sit on. The nebulae are running away from each other just as much as they are running away from us. What we are observing and measuring is a general scattering of a part of the nebulae.

There is no mystery as to the cause of this expansion. It is a consequence of the Theory of Relativity that there must exist a force, which we call cosmical repulsion, tending to produce just such a scattering apart of material objects. In all small-scale systems, gravitation which tends to draw material bodies together strongly predominates over the cosmical repulsion which tends to scatter them apart—so the scattering does not take effect. I ought perhaps to remind you that we are now thinking on such a scale of size that the Milky Way counts as a small-scale system. Even in a large-scale system like the system of the galaxies, it would be possible for the matter to be distributed so densely that its gravitation would balance the cosmical repulsion. But it has been shown that this balance would be unstable. We had therefore good reason to anticipate that if we could examine a system on a large enough scale, we should find the scattering force of cosmical repulsion outweighing the mutual attraction of the matter; and therefore the whole system would be expanding. That is what we now observe.

But although the expansion of the system of the galaxies was foreseen by theory, and its actual detection by astronomers is a striking confirmation of Relativity Theory, the rate of expansion turns out to be surprisingly rapid—I might almost say, alarmingly rapid.'' The nebulae will recede to double their present distances in 1300 million years. Astronomers will have to double the aperture of their telescopes every 1300 million years in order to keep them in view. But seriously 1300 million years is not a very long period in cosmic history; it is the age of some of the older rocks in the earth's crust. It is a shock to find that so complete a change in the universe has occurred within geological times.

The significance of the rapid expansion is that it makes it necessary to cut down considerably the enormous time scale of billions of years which was fashionable ten years ago. Fortunately this is in keeping with various other lines of evidence which suggest that the stars and galaxies are not so very much older than the earth.

Originally the Theory of Relativity predicted the expansion but not the rate of expansion, so that the rapid rate found by astronomical observation came rather as a surprise. I found, however, on looking into the question that existing physical

theory could be used to give a purely theoretical prediction of the amount. It has taken some time to complete this calculation since there were a number of obscure theoretical questions to be cleared up first; but last year I reached what I take to be the definite result, by two largely independent methods which check one another. In terms of the somewhat technical unit commonly used to measure the rate of recession, the calculated value is 432; this involves no observational data except such as have been ascertained by laboratory experiment which would be known to us even if we had no telescopes and had never seen a nebula. The entirely independent determination by observation of the recession of the nebulae gives a value 500, subject to a considerable uncertainty due to the difficulty of determining the absolute scale of nebular distances. The agreement lies well within the probable limits of error and, I think, leaves no doubt that the observed recession is actually the effect produced by Relativity Theory, and is not due to other unknown causes.

For reasons which I cannot enter into here, we believe that along with the expansion of the material universe there is an expansion of space itself. The idea is that these island galaxies are dotted all over spherical space and the sphere of space itself is expanding and so causing them to move apart from one another. It is as though they were attached to a rubber balloon, and the balloon was being inflated. Only unfortunately for my analogy, there is an extra dimension to be brought in, which is somewhat difficult to imagine until you get used to it. Of course, I know that this conception of closed space is very difficult to grasp; but really it is not worse than the older concept of open infinite space, which no one can really imagine. No one can conceive infinity or infinitude; we just use the term without trying to apprehend it. So if you feel that astronomers in accepting this new conception of spherical space are falling into the fire, please remember that we are at least escaping from the frying pan.

Spherical space has many curious properties. If you keep going straight ahead in any direction you will ultimately find yourself back at your starting point. It is analogous to what happens on the earth if you travel straight on; you go round the world and reach your starting point again. In the same way, if you look far enough in any direction, and there is nothing in the way, you ought to see the back of your head. Well, not exactly; because light takes at least 6,000 million years to travel round the universe, and the back of your head was not there all that time ago. But you see the idea. However, we need not trouble much about these curiosities, but do not suppose that spherical space is something that has been devised for the purpose of explaining the astronomical phenomena of the recession of the nebulae. So far as that is concerned, relativity explanation would hold as well in open space or in closed space. The fact is that infinite flat space became obsolete in serious physical theory, fifteen or twenty years ago; we described the phenomena of the expansion of the system of the galaxies in terms of spherical space, rather than in terms of flat space, not because it is easier to explain that way, but because we are living in the year 1938, not in the year 1918.

Now we have been all over the universe. And if the survey has been inadequate I may plead that light takes 6,000 million years to make the circuit which I have made in an hour. But the universe is expanding. And during the hour I have been speaking there has been an increase of the circuit amounting to 2 or 3 more days journey for the light. Anyhow the time has come to leave this nightmare immensity, and find our way back to the tiny planet attached to one of the myriads of stars in one of the millions of galaxies whence we started.*

* A popular lecture delivered in the Senate Hall, Calcutta University, on the occasion of the Silver Jubilee of the Indian Science Congress Association.

The 17th International Geological Congress

So much has happened in Russia during the last twenty years—since the Great October Revolution of 1917, when the Bolshevik regime definitely assumed control of the country—that a visit to the Union of Soviet Socialist Republics, under almost any circumstances, must be interesting. So much has been reported about the conditions in that country and so many claims have been made by Soviet geologists and other scientists in regard to their discoveries in the field and in the laboratory that foreign scientists were sceptical of these claims. In these circumstances my selection by the Director, Geological Survey of India, to go to Moscow as the representative of the Government of India to attend the 17th International Geological Congress held there in July 1937 was most enviable, especially as I was the only delegate from India. In the previous 7th International Geological Congress held in Russia, in St. Petersburg in August 1897, it happened that there was no delegate from India owing to some delay in the selection of a representative -Mr C. L. Griesbach who was unable to attend when recommended.

The International Geological Congress was founded in 1876 by a committee of geologists who met in Philadelphia, U.S.A., under James Hall with T. Sterry Hunt as Secretary. The other members of that committee were W. B. Rogers. J. W. Dawson, J. S. Newberry, C. H. Hitchcock, R. Pumpelly, P. Lesley, E. H. Huxley, Otto Torell and E. H de Baumbauer. The successive Congress meetings since have been as follows:—

Year.	*Place.*	*President.*
1878	Paris	E. Hebert
1881	Bologne (Italy)	G. Capellini
1885	Berlin	E. Beyrich
1888	London	J. Prestwich
1891	Washington	J. S. Newberry
1894	Zurich	E. Renevier
1897	St. Petersburg	A. Karpinsky
1900	Paris	A. Gaudry
1903	Vienna	E. Tietza
1906	Mexico City	J. C. Aiguilera
1910	Stockholm	G. de Geer
1913	Toronto	F. Adams
1922	Brussells	J. Lebacqz
1926	Madrid	C. Rubio
1931	Pretoria (S. Africa)	A. Rogers
1934	Washington	V. Lindgrin
1937	Moscow	I. M. Goubkin

The official languages of the Congress meetings are English, French, German, Italian and Spanish and that of the country in which a Congress is being held, but as in the case of the meetings in St. Petersburg in 1897 and in Moscow last year, Russian was only used on those two occasions. It is considered easier for our Soviet friends to learn one or other of the other languages than it is for us to learn Russian, but there is no doubt that this language difficulty was very real at the 17th International Congress. However, it was largely overcome at the opening and other meetings which were held in the large hall of the State Conservatory in Moscow by the provision of ear phones in every seat and each capable of being plugged to one or other of seven circuits to hear any speech in one or other of the above languages, either directly, or from interpreters, in any other of the same languages. The opening meeting on the 21st July, 1937, was in the presence of 1,000 delegates from 50 countries, and on each side of the platform in Russian, French, German, English, Italian and Spanish in bold letters were Stalin's words:—

"Science is called science just because it recognizes no fetishes and does not fear to raise its hand against everything that is obsolete and dying and attentively listens to the voice of experience, of practice"

Before the Congress meeting on July 21st excursions had been arranged for visits to the north (Kola peninsula and Karelia), to the south

(Ukraine and Crimea), to the Caucasus and to the Volga-Urals area (Permian excursion). After the Congress closed excursions were arranged to visit the Petroleum occurrences, Siberia, Nova Zembla, and the Urals, in addition to places near Moscow. I attended the Permian excursion as it was more closely related to the work I had been doing in India and was probably more palaeontological than economic. In fact it was very soon evident that economic geology was the chief concern of the Soviet Government and the subject of mineral resources was the main theme of the papers and discussions at the meetings of the delegates in Moscow, in Leningrad and at the various places visited during the excursion. It was a subject for complaint during the Russian meetings of 1897 that banquets played perhaps a more important part in the excursions than visits to exposures. We had nothing to complain against the excursions except that some were long days, nor can we say that banquets were too few for we were treated generously everywhere—from picnics in a Baskirian forest to a banquet in the Kremlin itself. We found the U. S. S. R. to be a geologists' paradise. Nothing seemed to be done in mineral prospecting, the development of mines, the exploration of oil fields, the erection of metallurgical works, the construction of canals and other engineering structures, and even in the reclamation of lands, without the opinion of the geologists engaged in that district or in driect consultation with the geological authorities in Leningrad.

Each mineral industry—gold, coal, petroleum, salt, mica, phosphates, etc.—has its own so-called Trust which may have branches all over the U. S. S. R. There is exploration everywhere and mineral and metallurgical works are in course of erection in various parts of the vast territories of the U. S. S. R., which are equal to half the area of Asia and fully four times that of India—yet with a population only half that of India. We were almost bewildered by the immense activity we saw wherever we went throughout the length and breadth of Russia, and it is not too much to say that the enthusiasm of those engaged and their intense pride in all their work showed that a nation had been established and was going forward. Our unbelief in the vast claims slowly disappeared as we travelled and met geologists almost everywhere and saw their maps, their mines, their technical schools and colleges. Somehow it was no shock to us when we learned that over 10,000 geologists were engaged on State surveys or in the Trusts or in Universities and other scholastic institutions. Their equipment is not equalled in India, their museum collections (especially those in Leningrad) are splendid and well housed, their research laboratories are lavishly supplied and their work is equal to any geological work. In physics and chemistry, in geo-chemistry and geophysical work they have little to learn from other countries. In fact it is difficult to express in words the high standard of the work—whether it be connected with the atomic structure of elements, the study of crystal structure, the synthetic production of minerals, the investigation of mineral associations in ore deposits or pegmatites, or palaeontological and palaeobotanical determinations—that is being steadily and carefully done in numerous centres.

I stood in Mendeleyev's room in Leningrad and saw his books and papers still kept as he left them, and what impressed me most was the fact that he used glass weights for his chemical balance weighings. They are clean, easy to pick up and far easier to adjust against standard weights where calibration is necessary. We also saw the famous Berezov mammoth which had been found in the Yakutsk region within the Arctic Circle in 1900 and taken to St. Petersburg in 1902 and is now in the Zoological Museum there (Leningrad). We disappointed some of our Soviet friends by criticizing the restoration which suggests an old animal which had died, in its sleep, whereas it is a fine young male which had met with an accident—fallen into a crevasse—and died quickly after a struggle as food was found in its mouth and the pelvis was fractured. So perfect had been the preservation when found that the flesh of the shoulders was still fresh and was fed to the sledge dogs (see 'The Frozen Mammoth in Siberia', by O. F. Herz, *Ann. Rept. Smithsonian Inst.* for 1903, p. 611, 1904).

It may be said that the scientific standard of work is set by the Institutes controlled by the

THE 17TH INTERNATIONAL GEOLOGICAL CONGRESS

Academy of Sciences, while the efficiency of geological work—mapping, mineral study, etc.—is guided by the Geological Survey Committee and the Central Geological and Prospecting Institute for Scientific Research (TSHIGRI) in Leningrad. It must not be concluded that a geologist is free to do research work at his own time all the days of his life. This is not the view of the Academy and Survey authorities who are responsible to the Soviet Government from whom the generous grants are obtained for scientific research, expeditions, surveys, prospecting and for exploration and development. The mineral resources of the U. S. S. R. have not only to be found, studied and estimated, but must supply the needs of the country's industries. With all land and minerals belonging to the people, under the control of the Government, nationalization of industries is a fundamental matter and so a great deal can be done to co-ordinate development. It is the policy of the Government to make each Autonomous or Union Republique dependent on its own mineral resources for its industrial wants. Consequently geological search is widespread through the U. S. S. R. Geologists vie with each other to make discoveries and, as may be imagined, subject each other's discoveries to severe scrutiny. It is not wise to claim more than you can justify and there is little place for a geologist lacking energy - the expenditure on his training must be justified either by hard work or great ability.

We found the Soviet geologists anxious to exchange publications, and in order to help us to read their contributions to geology they are putting in an English summary in most of their monographs and other papers of interest. I found all those with whom I came into personal contact friendly and glad to exchange views and give any information within their power. With delegates travelling widely in the U. S. S. R. and everywhere finding schools, colleges and universities, where large towns were springing up or coming to life again, and a vast industrial development in progress, it is evident that, at least scientifically, geological training has been arranged for on an immense scale. This could only come by the realization of the Soviet Government of the importance to the country of the true usefulness of the geologist, properly equipped and employed. The Russian geologist has to some extent been fortunate in that his vast country had been but poorly explored before and is far richer in minerals than many still believe possible. The point of the 17th International Geological Congress was to show us that Russia is second to none in geological work and we must admit that they have proved all their claims and congratulate them for showing the value of the geologist to their Government.

—*C. S. Fox.*

Exhibit of Rare Sugars

At the meeting of the American Association for the Advancement of Science held in Indianapolis December 27-30, inclusive, the Bureau's polarimetry section exhibited a collection of rare sugars which is unique in that it includes all of the pentose, hexose and heptose aldose sugars of the *d* configurational series which are known products at the present time. These sugars have been prepared by various members of the staff without seed crystals from other sources. The group comprises four pentoses, eight hexoses, and eight heptoses, all of which are in the crystalline state with the exception of *d*-idose which has never been crystallized. The following sugars in the collection were crystallized for the first time at the Bureau:

d—allose,
d—β—Glucoheptose,
d—α—Guloheptose,
d—Gulose $CaCl_2$,
d—β—Mannoheptose.

—*Jour. Frank. Inst.*

Meteorology in India

We have just before us the Report on the Administration of the Meteorological Department of the Government of India during 1936-37. It describes the wide expansion and the substantial improvement in the services that the department rendered to aviation, agriculture, and shipping, apart from its normal activities. The report states that the department had to develop new facilities to meet

(*a*) The steadily increasing demands of weather reports along the air routes on account of increasing frequency in flying including night flying;

(*b*) The preparation of a second daily weather chart;

(*c*) The establishment of a short-wave wireless station at the Meteorological head quarters; and

(*d*) Broadcasts of special information from Karachi, Calcutta and Rangoon.

One of the best criteria for judging the activity and the useful services rendered by such a department is to be found in the number of various messages handled. The report shows that, during the year, over 37000 messages consisting of forecasts, warnings to ships, reports to ports, and warning of heavy rainfall and frosts to agriculturists were issued. This comes to over 100 messages per day and apart from this more than 10,000 wireless messages were received from ships. It is to be noted that the number of messages in every one of the various headings was much greater during the year under review than the corresponding figures in the previous year.

With the prospect that aeroplanes will fly more frequently by night as well as by day, preliminary experimental work had to be carried out in connection with the standardization of equipment for observing *balloons* and measuring visibility, cloud height at night and other allied problems and provision had to be made for supplying more information. The number of current weather observations exchanged daily by wireless on the Karachi-Calcutta route was increased from 2 to 3, one of the observations being taken and wirelessed before dawn each day for the benefit of airmen leaving terminal stations early in the morning. In addition to these improvements in the routine scheme, arrangements were made for certain special observations on flying days of the Imperial Airways, consisting of an early morning current weather observation at Akyab and Chittagong for the use of east-bound planes leaving Dum Dum, a midday pilot balloon ascent at Akyab for the use of west-bound planes leaving Rangoon, and an early morning pilot balloon ascent at Sherghati.

New pilot balloon stations were opened at Delhi and Trichinopoly in order that full data about upper air winds might be regularly obtained. Steps were taken for the training of the civil aviation personnel at certain emergency landing grounds for sending reports of dangerous phenomena and for taking timely precautions. The question of the supply of weather reports for air-men on the sea-plane route across India was investigated. Of other important matters relating to aviation may be mentioned the introduction of the 'AER Met' scheme according to which aircraft in flight takes observations of weather, particularly during monsoon or other difficult weather, and transmit them by wireless for the benefit of other aircraft and of forecasting centres. The success of the scheme may be judged from the fact that nearly a hundred AER Met messages were received during the year.

It is well known that in many other countries 4 to 6 charts are prepared each day at the forecasting centres, but as these systems are very expensive Poona had to get on with only one chart a day. There is no country is the world except India where a forecasting centre has to forecast

for aviation with only one chart a day. This serious deficiency was mitigated by the introduction of a second daily weather chart at Poona which was made possible by the successful working out of a scheme of economies in telegraphic expenditure. This procedure has led to substantial savings. In fact, the savings were sufficient to establish a shortwave wireless station also at Poona.

The need for exchange of weather reports with neighbouring countries continued to be felt, and fortunately it was possible towards the end of the year to arrive at decisions which rendered it possible to start regular broadcasts of meteorological data from the shortwave aeronautical wireless stations at Rangoon, Calcutta, and Karachi. The starting of the shortwave station at Poona and of broadcasts from Delhi, when a meteorological office is started there, will give a very good and useful network of broadcasting stations. It is hoped that these broadcasts will be heard by neighbouring countries and some of the meteorological broadcasts from neighbouring countries will be received in India. This arrangement will enable the meteorological services of different Governments to draw weather maps for the whole of south Asia—a step which has been awaited for a number of years, and one which will lead to a clearer understanding of weather changes over this part of the globe.

Important additions to the inland warning work of the department have been made during the year at the instance of the Imperial Council of Agricultural Research and of the Government of Bombay. One of the schemes aims, by issue of timely warnings to the areas concerned, at minimizing damage to crops by frosts. According to the second scheme introduced at the instance of the Bombay Government, Collectors and Deputy Directors of Agriculture in the Presidency were warned against heavy or untimely rainfall and against low temperatures. Both schemes are being tried on an experimental basis for 2 years. With the existing meteorological organization it is only possible to predict conditions generally over the major meteorological sub-divisions of India, and in the experimental stage the warnings are being issued with reference to groups of two or more districts which form a homogeneous meteorological unit. Reports received from the officers on the warning list indicate that the messages were timely and generally useful, but that difficulties were experienced in transmitting the information sufficiently and quickly to agriculturists. Full advantage of service will be obtained only when every village has a wireless receiver so that quick reception of the news is rendered possible.

Some of the officers have also indicated the necessity of these warnings reaching them longer ahead than has hitherto been possible and it is expected that the preparation of the afternoon chart at Poona which has been sanctioned with effect from 1st April 1937, will improve the situation in this respect in future.. With better facilities for disseminating the warning messages and the education of the agriculturists in using the reports, better results may be expected in the matter of prevention of damage to crops and other properties.

The marine meteorology section also worked very well. The storm warnings issued to posts were mostly timely and useful as is shown by the satisfaction expressed by the post authorities in their reports. The number of messages issued during the year was much greater than that in the previous year.

The Agricultural Meteorology section carried on investigations of the local climates and growth rates of crops and also on frequency of hail, droughts, floods, and cold and heat waves. It also carried on experiments intended to provide a measure of the different ways in which solar energy and rainfall are disposed of at the earth's surface. Experiments on soil temperature and their dependence on the nature of the soil layers were also undertaken. Researches on (1) the exchange of heat energy by radiation between the soil and the atmosphere, and between the different air layers themselves, (2) the influence of water vapour in the atmosphere on these radiation processes, and (3) the radiation equilibrium of an object near the ground in relation to the zenith distance of the portion of the sky concerned, etc. were carried out, and the results arrived at were

of great value in understanding the phenomenon of nocturnal cooling. Another subject in which further progress was made is the exchange of moisture between the soil and the air layers near the surface. Some of the Indian soils, *e.g.*, the black cotton soil, are found to be so hygroscopic that, when dried completely, they can be used as efficient desiccating agents. The direct estimation of soil moisture at different depths at weekly intervals was continued. As a result of experience gained in the section, it has been found that the simple 'Piche' evaporimeter exposed in the Stevenson screen would provide useful estimates of evaporation. The Imperial Council of Agricultural Research passed a resolution to the effect that Agricultural Meteorology should become one of the permanent activities of the Government. Formal proposals for making the section permanent are now under the consideration of the Government of India.

A number of sounding balloons were let off from Agra, Madras and Poona to study the upper air conditions. At Agra measurements of the horizontal transmission co-efficient of the atmosphere and of the cosmic ray intensity were started. At Kodaikanal studies were made of "oxygen in prominences," of the progressive change in inclination of the hydrogen dark markings to the meridian of the sun and of the lines of hydrogen and calcium in the Fraunhofer spectrum at different points of the sun's disc, and at Bombay the day-to-day variability of the horizontal force of the earths' magnetic field and also of the earth-air currents from elevated points during times of thunderstorms were studied. At Poona a detailed distribution of rainfall in South India was examined, and statistical work to improve the existing forecasting formulae was continued. Dr T. Royds went on deputation to Japan to observe the total solar eclipse on the 19th June 1936 with a view to make an accurate determination of wavelengths in the sun's spectra during partial phase of the eclipse and was successful in obtaining the desired photograph.

The recent unfortunate incidence of a series of earthquakes in India has focussed attention to the great necessity of instituting a branch of public service which would devote its attention exclusively to the problem of seismological investigation and in view of the importance of investigating on proper lines the seismological problems of India, a conference was convened in January 1936, at which the Surveyor General, the Director of Geological Survey of India, and the Director General of Observatories examined the question of setting up a seismological organization in India and recommended its establishment. The proposal was approved by the Government of India, but the scheme was postponed for financial reasons.

—*R. R. Bajpai.*

No Summer Layoffs Now in Air Conditioned Mine

High temperatures and high moisture content of the air in the Magma Copper Mine at Superior, Arizona caused summer layoffs for the workmen amounting to about four weeks each year. The temperatures were caused by heat which rises from the lower levels of the earth, and conditions became worse as the mine grew deeper. The humidity was caused by evaporation of the larger amount of water found underground. To correct these conditions a Carrier air conditioning system, similar to that in the Deep Gold mines in South Africa, was installed. After the first few days of operation, spokesmen for the miners requested permission to resume work. This is the first underground air conditioning in the United States.

—*Jour. Frank. Inst.*

Notes and News

Plant Physiology in the U.S.S.R.

The contribution of Russian scientists to different aspects of plant physiology is remarkable. V N. Lubimenko's article on the development of plant physiology in the U. S. S. R. (*Plant Physiology, 12* 895) is therefore most appropriate.

Classification and geographical distribution of plants were the first branches of plant science to which Russian botanists first turned their attention. Even then the first school of plant physiology was founded in " the sixties of the last century " by A. S. Famintsyn (1815-1918) among whose pupils were Baranetzky and Borodin. The development of plant physiology was more marked " towards the end of the 19th century and in the beginning of the 20th century " during which period such eminent physiologists as C. A. Timiriasev, V. I. Palladin, S. P. Kostychev, D. N. Prianishnikov, A. A. Richter, V. V. K. Zalessky, V. N. Lubimenko, N. A. Maximov, N. G. Kholodny founded their schools.

A new impetus was given to the study of plant physiology after the October Revolution when new universities, botanical gardens and agricultural experimental stations were organized. New tendencies began to manifest themselves in research work; instead of studying separate unconnected functions of the organism, attention was turned to the organism itself— " the organism as a living, dynamic whole."

The internal factors controlling the various physico-chemical reactions taking place within the organism are now receiving more and more attention. The minimum, optimum and maximum in physiological functions have lost their previous significance; " they have now become an expression of the dynamism of the organism itself," a true index of protoplasmic changes. This new mode of study has yielded interesting results in the investigations of A. C. Danilov, V. A. Brilliant, A. K. Toshchevikova and A. L. Kursanov on different aspects of photosynthesis; it has been extended to researches on frost resistance, heat resistance, drought resistance (N. A. Maximov, I. I. Tumanov, A. A. Richter, V. N. Lubimenko and others), on mineral nutrition (O. A. Walter, D. A. Sabinin and their collaborators) and on nitrogen nutrition (D. N. Prianishnikov and others). Along with these stand the works of N. G. Kholodny, who is one of the founders of the hormone theory of growth.

" The favourable results in agricultural practice of the method elaborated by Lysenko of the preliminary yarovisation of seed " have served as a powerful incentive to research work on the physiology of plant growth and development.

The problems tackled are primarily those that have the greatest bearing on the agriculture and industry of the U. S. S. R., the economic structure of which makes it possible to easily translate into practice the results of scientific investigations. " Lysenko began to apply his method to field trials in 1931 and already millions of hectares are being sown with yarovised seeds." Both the government and society have high estimation of scientific research work. An account of the theory and practice of the method of vernalization has been given by A. K. Mitra in SCIENCE AND CULTURE July, 1937.

The Entomological Society of India

Those interested in the insect life of India, will welcome the news that the Entomological Society of India was inaugurated during the Silver Jubilee Session of the Indian Science Congress. Such an organization was long overdue in India where insect fauna is so rich and varied and insect activity, both harmful and beneficial, has such an important bearing on the economic interests of the population. The Society, therefore, aims to promote the cause of entomology in all its aspects and to cooperate with other organizations having a similar object, in India and abroad.

As, in a vast country like India, it is very difficult for members to meet together oftener than once in

the year, the Society has started branches in the following entomological centres.

Centre.		*Secretary.*
Calcutta	..	Mr D. D. Mukerji.
Dehra Dun	..	Mr N. C. Chatterji.
Lyallpur	..	Dr K. A. Rahman.
Karachi	..	Rao Bahadur Ram Chandra Rao.
Coimbatore	..	Rao Sahib T. V. Rama Krishna Ayyar.
New Delhi	..	Dr K. B. Lal.

These branches will periodically hold meetings during the course of the year, and members from all parts of the country will meet together annually, usually with the Indian Science Congress. Other branches would be formed, if a sufficient number of members join the Society from any one place. Important papers read and business transacted at the various centres will be published in the Journal of the Society.

The admission fee is Rs. 10 - and annual subscription is also Rs. 10/-. It is to be hoped that all those who are interested in any phase of insect activity will join the Society and increase its usefulness. Further information may be obtained from any one of the branch Secretaries or from Dr K. B. Lal, Second Assistant Entomologist, Imperial Agricultural Research Institute, New Delhi, who is acting as general Secretary and Treasurer of the Society.

Geological Survey in Burma

The Geological Survey of India have recently brought out a memoir, in which details are given of the geology of the eastern flank of the Arakan Yoma and Chin Hills in Burma and of the country between these hills and of the Irrawaddy River including the oil field of Yenangyat as also of a small portion of the Myingyan and Magwe districts east of the Irrawaddy. Amongst the conclusions reached is that the belt of the Eocene rocks shown in the geological map of India as occurring in the central Yoma region is probably an error. It must be confessed, says the memoir, that in regard to oil-prospecting, the survey is valuable largely for its negative results. The entire area covered has been carefully examined and the conclusion has been reached that from the structure and geology of the country, it seems probable that no important new oilfield is likely to be found. Again although the survey has revealed the presence of coal-seams up to 6 feet in thickness in the basal pegus (shwezetaw stage) in Pakokku, the quality of this lignitic coal is very poor and the deposits, it is said, are possibly valueless. A description is also given in the memoir of an occurrence of copper ore in the Pakokku Hill tracts.

Has the Gangotri Glacier moved?

Mr J. B. Auden of the Geological Survey of India, who made a recent examination of the Gangotri Glacier in Tehri Garhwal State gives it as his opinion in a paper contributed on the subject to the *Geological Survey Records* that this glacier, like many others in India, has retreated extensively within recent times, probably within the last century.

Systematic observations of glaciers are now made in most glaciated regions of the world, and it is hoped eventually to be able to correlate glacial phenomena with climatic conditions. Though because of the short duration of the observations, such correlation is at present seldom possible, it is believed that if glaciers are studied long enough, valuable information will be obtained for the study of climatic cycles.

Need for Co-operation of Scientists and Politicians

In course of his speech before the seventh annual meeting of the National Academy of Sciences, Allahabad, Pandit Jawaharlal Nehru dwelt on the significance of science and true religion and observed, " Perhaps there is no real conflict between true religion and science, but, if so, religion must put on the garb of science and approach all its problems in the spirit of science. It is time we brought up our minds in line with the progress of science and gave up meaningless controversies of an age gone by. It is true that science changes and there is nothing dogmatic or final about it. But the method of science does not change, and it is to that we must adhere in our thought and activities, in research, in social life, in political and economic life, in religion."

Regarding the importance of the co-operation of scientists and politicians in tackling problems of national reconstruction, Pandit Nehru said, "We have vast problems to face and solve. They will not be solved by the politicians alone, for they may not have the vision or the expert knowledge; they will not be

solved by the scientists alone, for they will not have the power to do so or the larger outlook which takes everything into its ken. They can and will be solved by the co-operation of the two for a well-defined and definite social objective. The greatest of our problems is that of the land, but intimately connected with it is that of industry. And side by side with these go the social services. All of these will have to be tackled together and co-ordinate together. That is a vast undertaking but it will have to be shouldered." Finally Pandit Nehru observed that he would like India to look at everything from a scientific viewpoint. He would like the Government to take full advantage of what the scientists offered.

Anti-Tuberculosis Campaign in India

Everyone in India is deeply concerned at the wide prevalence of tuberculosis in this country. There is no doubt that tuberculosis usually in the pulmonary form, is the most insidious disease that India has to face. It is always exacting a heavy and constant toll. Although it is impossible to state with complete accuracy how many die each year in India from tuberculosis, as the vital statistics throughout the country as a whole are not sufficiently complete, a brief statement is given here, showing by comparison the number of deaths from pulmonary tuberculosis per 100,000 of population in certain English cities in 1933, and of some Indian ones in 1934.

Ipswich	53
London	82
Birmingham	86
Manchester	104
South Shields	138
Lucknow	223
Calcutta	230
Poona	324
Ahmedabad	389
Cawnpore	422

The above figures reveal an appallingly high death rate from tuberculosis in India. The rate is in all probability increasing every year, for the people are highly susceptible to this disease.

It is, therefore, in the fitness of things that an anti-tuberculosis drive has been lately launched on a countrywide basis under the patronage of their Excellencies Lord and Lady Linlithgow, and policies are now being developed for an intensive campaign in this connexion. A sum of Rs. 21,68,305/3/7 has been subscribed to the King-Emperor's Anti-Tuberculosis Fund, which has had good response both from British India and the Indian States. Deep interest in the Fund is also being shown in Great Britain, where a group of influential people have recommended it to the British public. Provincial Committees have been formed in connexion with the Fund which will promulgate its aims and purposes in lectures. Leaflets, pamphlets, and posters are being prepared for all-India distribution, and special efforts are being made to reach the rural population by means of publicity carried out in the Indian vernaculars. Exhibition booths are also suggested to be established at important melas throughout the country, where visitors will be supplied with literature regarding the disease. We hope that the people of India will be aroused to co-ordinate effort and that the campaign against tuberculosis will show increased activity and true direction.

The Central Advisory Board on Primary Education

Primary education is receiving at present a good deal of attention from all thinking men and educationists in this century, and its compulsory introduction in the various provinces formed one of the main planks on which the last provincial elections were fought and won. The various governments in the provinces in British India holding office for the first time on a popular vote under the India Act of 1935 are solemnly pledged to it in their respective provinces, and steps are being taken and ways and means devised to surmount the difficulties in the way, which seem now to be more serious than they were at first expected. The Central Board of Education appointed a committee to consider certain questions connected with the administration and control of primary education. The committee was presided over by the Hon'ble Mr B. G. Kher, Chief Minister of the Bombay Government, and it included, besides the Educational Commissioner with the Government of India, several provincial directors of public instruction. They recently submitted their report to the Board. An advisory board on vernacular education for each province, an improved Government inspectorate with powers to control, a survey of the existing schools, and progressive advance in the introduction of compulsory

primary education—these are some of the recommendations of the committee.

The advisory board to be set up in each province will consist of not more than seven members, of whom one at last will be a woman, with the Minister of Education as the chairman. The members of this board should be appointed by the Ministry. It will not be the function of the board to deal with the technique of teaching but with the wider questions of expansion, control and administration of vernacular education and with the financial aspect of these questions.

The committee are of opinion that an improved Government inspectorate is at present necessary to improve the administration of primary education. Every district inspector should be a member of the Provincial Service. Unless a special administrative officer is appointed, the inspector should act as the administrative officer of the local body in all matters affecting vernacular education. All questions of transfer, appointment, dismissal and increments should be decided by him in consultation with the Divisional Inspector in the case of Anglo-vernacular teachers. In all matters concerning women teachers, the district inspectress should have the same powers. The inspectorate should be appointed by the Government.

The committee do not recommend the introduction of universal compulsory primary education, for that would create more difficulties than it would solve, apart from the question of "appallingly high" expenditure it would entail upon the provincial exchequer. They therefore urge that, as the 75% of the money now spent on primary education is sheer waste, it be prevented and that the funds at present available would obviously suffice for a great extension. The mere passing of a Compulsory Education Act even in those areas where compulsion is considered desirable will not in itself either bring children to schools or keep them there. The effective administration of the Act is necessary.

We are of opinion, the committee observe, that a much more rapid advance in compulsory primary education is possible in many provinces and that the best lines of advance are similar to those of the Punjab (and other provinces) where compulsion is applied not to the province as a whole, perhaps not even to municipalities, but to village areas where the majority of the children already attend school and to selected wards of a municipality. We should like to see all provinces make a survey of the existing schools as has been or is being carried out by the United Provinces and Madras with a view to the wiser location of schools, the improvement of inefficient schools, the closure of unnecessary ones and the amalgamation of others. It should not then be difficult after a survey and study of different districts to formulate a programme spread over a number of years, which should aim not only at the development of primary education in those districts, but also to the extension of compulsion. Such a survey should be carried out by the Government inspectors in consultation with the local education authority.

The Annual Report of the Educational Commissioner

The annual report of the Educational Commissioner with the Government of India during the year 1935-36 which has just been released for publication gives expression once again to the sorry state of education as imparted in this country. All are agreed, says the report, that stagnation and wastage are appalling, that the administration of primary education by local bodies shows no improvement and is thoroughly inefficient, that compulsory primary education appears as remote as ever, that the annual increase in the percentage of literates is disconcertingly small, that the universities contain many students who are unfit to profit by higher academic studies, that unemployment amongst the educated classes is common and that provision for the education of girls is ludicrously inadequate. The Education Commissioner holds the same view as the Committee appointed by the Central Advisory Board, as referred to above and says that "the plea of lack of money can no longer excuse apathy, for the money now available for primary education could support a wide expansion, were administration more austere and wastage eradicated."

The number of educational institutions, according to the report, has decreased by 2,052 from 256,263 in 1935 to 254, 211 in 1936. The decrease is mainly in primary schools and is generally due to the elimination of inefficient schools. It need not therefore give cause for alarm especially when the enrolment has

increased by 309,280 to 13,816,149 in the year under review. The total expenditure on education in British India has increased by about Rs. 81 lakhs, *i.e.*, from Rs 26½ crores in 1935 to Rs 27 crores 33 lakhs in 1936. Of this increase of 81 lakhs, only Rs 9½ lakhs was spent on the institutions for girls. The number of students in the universities in India including professional colleges increased by 7,105 to 124,508 in 1936.

Primary Education of Girls

The women's Education Committee of the Central Advisory Board of Education has recently reported on the girls' primary education in India. It deals with, in detail, the various important points often raised in connexion with girl's education in our country, and the report demands close attention in view of the general apathy and laxity in matters of female education, though of late, it is reassuring to find, a little more interest is being taken of it. The Committee was presided over by Lady Grigg, and consisted besides the Commissioner of Education with the Government of India, of several inspectresses of schools and persons interested in girl's education.

The aim of the primary school, the Committee state, quoting with approval from the Hadow Report, should be " to develop in a child the fundamental human powers and to awaken him to the fundamental interests of civilized life so far as these powers and interests lie within the compass of childhood, to encourage him to attain gradually to that control and orderly management of his energies, impulses and emotions, which is the essence of moral and intellectual discipline, to help him to discover the idea of duty and to ensure it, and to open out his imagination and his sympathies in such a way that he may be prepared to understand and to follow in later years the highest examples of excellence in life and conduct."

It is not so much a matter of teaching a prescribed minimum of knowledge in certain subjects necessary though this knowledge might be, as of providing opportunities for healthful activities. The curriculum should, therefore, be thought of not so much in terms of knowledge to be acquired, as in opportunities for each child to occupy herself in wise adjustment to her environment and to the society of which she is a part. In short, as Mr Wood says in the recent report on vocational education in India, the child " needs experience rather than instruction."

The Committee feel that in primary schools no distinction in curriculum is necessary, as the interests, activities and the life of young children are much the same whether they are boys and girls, nor need the methods of teaching this curriculum be different.

The Committee, therefore, prefer mixed schools to separate schools for boys and girls not merely on the ground of economy but educationally, and urge that every effort should be made to increase the supply of suitable women teachers and heartily endorse the opinion of Mr Wood in his recent report that " until a system of infant classes staffed by trained women is established in India, education will remain unsound at its very foundation."

Because of the need of relating the child's activities to her environment, emphasis on the " content " of various subjects will differ according to the location of the schools. Thus a town school affords greater opportunities for emphasis on industries, with associated activities, whilst the rural school is better situated for outdoor activity, gardening and allied topics.

As regards English, the Committee are of opinion that it should not form part of the curriculum of a primary school, although several members felt that conversational English might continue to be taught.

While opinion was not unanimous in the Committee on the question of the inclusion of religious instruction in the curriculum, there is agreement that education divorced from religion is sterile and that primary education without teaching the basic principles common to all religions is incomplete. All are agreed also that moral ideas and habits must be developed, though there is a difference of opinion as to whether teaching should be direct or indirect.

Physical training, according to the Committee, is as important as mental training and should include games, simple rhythmic movements, song, drill, and simple drama. The aim should be not so much precision of movement, but such games and activities as will evoke enjoyment and give healthy exercise, as also posture, grace of movement and all those activities collectively known as eurhythmics.

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After discussing the general principles, the Committee conclude that the curriculum of a girls primary school of four or five classes should consist of languages, which include reading, writing (handwriting and expression), speaking; simple arithmetic not divorced from the experiences or environments of the child together with familiarity with the shape, size and weight and the simple properties of various common bodies and shapes, acquired through practical work; physical training for health, posture and enjoyment; handwork—such as drawing, simple cookery and laundry, needlework and suitable craftwork, which will not only help the co-ordination and adjustment of various activities, but will also help towards a child's understanding of objects presented to her and afford an opportunity of self-expression; history, geography and science not as formal subjects of study but to give information, to arouse interests and to prepare for more serious study. Folk stories and legends should also be included. The child should know something of the heroes and heroines not only of her own country but of other countries, their deeds of great events in the history of their own country and of the world.

It is also desirable that she should know something of the life of children in other lands and she should be taught simple facts and laws of health, causes of common diseases, the more important features of plant and animal life and be encouraged to keep pets, whenever possible and to make collections of various natural objects and to interest herself in the school garden.

The most important point, the Committee emphasize, is not to regard the above as separate subjects, with text-books and prescribed periods on the time-table, but activities to be taken up when suitable opportunities occur. The Committee agree that a time-table might be necessary but the period should be elastic and changeable by the teacher according to the circumstances.

The teacher is more important than any syllabus. No curriculum can be satisfactorily taught and no school made attractive unless the teacher has an understanding of the principles underlying her methods and how those principles are worked out in accordance with the child's nature.

Even the keenest young teacher requires help, guidance and kindly encouragement. Such help should come from the inspecting officers who ought to spend some considerable time in each school not with a view to fault finding, but to carry ideas from school to school to illustrate how they can be carried out and to stimulate the teacher.

Lastly the Committee are of opinion that a simple test should be held at the end of the primary course, which should consist of written papers in language, arithmetic and possibly a paper containing easy questions on the scope of geography, history and science courses.

An Appeal to the Scientists of the World

The whole world seems to be caught in the grips of war. The hounds of war have been let loose in the West and the East. While the lawful republican government of Spain has been fighting desperately for her democracy against a section of her people instigated and aided by some foreign powers, while Japan is striving to establish her own authority on China and hold her in servility, the Nazi Germany sees it only proper and just to interfere into the affairs of Austria and bring it under its control. Talks of non-intervention are of no avail, disarmament conferences fail, treaties and pacts are treated with scant contempt as "scraps of paper." That is the world situation, which is fast heading to a climax.

In these days of ignoble strife and dissension, of lust and hatred, of greed and fear, of pride and jealousy, it is reassuring to notice here and there attempts of some well meaning, peace-loving persons who are earnestly hoping for peace in the world and trying their best towards the achievement of this end. An appeal has recently been issued by Dr Bhagavan Das, M.L.A., of Benares who has been for some time past giving serious thought to this intriguing question and he has in it urged upon the scientists and educationists of the world to unite and join hands to explore avenues for world peace, for he believes that the solution of this lies with them. "How to check, he says in his appeal, this advancing horror; how prevent another and far worse Armageddon; how ensure world-peace; how bring about world wide disarmament by mutual agreement, how neutralize and deaden those deadliest, most powerful, most

destructive explosives, the evil human passions of whole nations—this has, therefore, become the greatest, the acutest, the most urgent problem of the day. The scientists who discover the effective solution of this problem will have made the greatest and most beneficent discovery of all ages, and will win the veneration, nay, the worship of all mankind. The universities and the greatest, most thoughtful, most philanthropic scientists of the time should bend all their energies to this greatest of all tasks, putting aside all others till this is successfully accomplished. They should teach to the world the best way to peace by means of the best form of social organization." We do not know what end, this appeal, however noble and earnest and well intentioned it may be, will achieve. The world to-day is ruled by brute force, it is hardly guided by knowledge and wisdom. We see all around us that the weak are being oppressed by the strong, the poor exploited ruthlessly by the rich, the helpless persecuted by those, who hold power and authority, -- misuse of which is the order of the day. The result is that there is discord in the world. Humanity is in imminent danger. It therefore appeals to the scientists, if they can save it, and cries: "Scientists of the world, unite and show us the right way, for humanity has everything to lose, it perishes if you don't; and if you do, it is saved, it lives, it finds peace and happiness for all."

Radio Research in India

We had occasion to comment in these columns more than once on the necessity of the establishment of a Radio Research Board in India (*vide Science and Culture*, *1*, 755-58, 1937, *2*, 469-72, 1937). Our contemporary, *Nature*, has also dwelt on this point several times in the past. We are glad to note that it has again taken up the matter in a recent issue (Feb. 26, 1938) while referring to the Presidential Address of the late Lord Rutherford which he had prepared before his death for the Jubilee Session of the Indian Science Congress. We quote below the remarks of *Nature*:

"Reference has been made from time to time in the columns of *Nature* to the desirability of encouraging the carrying out in India of fundamental radio research of the type sponsored by the Radio Research Board in Great Britain. This matter was referred to in the presidential address prepared by the late Lord Rutherford for the recent Silver Jubilee meeting of the Indian Science Congress. It was pointed out that the investigations conducted in Great Britain on the propagation of radio waves over great distances have considerably increased our knowledge of the upper atmosphere. The details of the electrified regions of the atmosphere vary considerably with the hour of the day and with the season of the year as well as with geographical location. The results are of great practical importance in the selection of the most suitable wave-lengths for radio communication, and, in addition, it does not seem impossible that such studies may prove of value in long range weather forecasting. There appears, therefore, to be scope for research on this matter in a wide field and in various parts of the world, and Lord Rutherford expressed the hope that it will be vigorously pursued in India. Reference was made to the very promising beginning that has already been effected by Profs. S. K. Mitra and M. N. Saha and their students in attacking fundamental radio problems. As an instance of the important work which is in progress in other parts of the Empire, mention was made of the admirable progress made in this field by the Australian Radio Research Board, which was established nearly ten years ago."

New Cavendish Professor

William Lawrence Bragg has been chosen to succeed Lord Rutherford of Nelson as Cavendish Professor of Experimental Physics at Cambridge. One of the most brilliant scientists of the day, Prof. Bragg was born at Adelaide, South Australia, on March 31, 1890. He was educated first at St. Peter's College, Adelaide and the Adelaide University, and then at Trinity College, Cambridge, of which he became a Fellow and a Lecturer in Natural Sciences in 1914 when he was only 24. A year later he was awarded the Nobel Prize in Physics jointly with his father Sir William Bragg, O.M., D.Sc., F.R.S. for work on X-ray and crystal structure. Prof. Bragg left Cambridge in 1919 to take the chair of physics at the Victoria University of Manchester, and last year became the Director of National Physical Laboratory. Men of Science all over the world will agree that no better choice could be made to take charge of the Cavendish Laboratory where Lord Rutherford and Sir J. J. Thompson before him did so much notable work on the atom.

NOTES AND NEWS

Important Archaeological Discovery

The discovery of several coins of the 10th-12th century A.D. and of five large earthenware jars of an earlier period is reported from an old city close to Moradabad. The place which is known by the name of Ujjain Fort, was visited by General Sir Alexander Cunningham 75 years ago and identified as the city of Govisana mentioned in the accounts of the travels of the Chinese pilgrim, Hieun Tsang. The ruins, as marked by conspicuous mounds, extend over about five miles to the north and a mile and a half to the south, but the width does not exceed three furlongs. It is perhaps the long and narrow shape of the city which accounted for the name "Govisana," cow's horn, and the peculiar configuration may have been due to the fact that the city was situated on the high bank of the river Kosi, of which several distributaries run in the neighbourhood. These ruins, which are covered with thick jungle, were recently visited by Mr. Madho Sarup Vats, Deputy Director-General of Archaeology in India, who made some trial soundings. From the uppermost stratum came a few coins of the 10th-12th century A.D., and what seems to be an earlier level of occupation is represented by five large earthenware jars with broad mouths and rope ornamentation around the shoulder. The latter are associated with large sized bricks about 16 inches long which go back to the Gupta period and may even be earlier. The trial trenches show that regular excavation in the area is likely to prove fruitful.

The Flood Problem of Orissa

The calamity parts of India have to face every year due to floods is severe. The question of floods has been agitating the mind of all lovers of India for a long time, but nothing substantial has been yet done to solve it. The Government of our country whose duty it is to tackle such problems for the safety of the people and improvement of the regions affected by such catastrophes would not consider its solution a practical proposition for financial reasons. Recommendations of experts and committees set up with a view to find out ways and means for this serious problem are seldom given effect to, and, if at all, partly and inadequately. The province of Orissa is particularly a victim to yearly floods and much of Orissa's miseries will end if this problem is successfully tackled. In 1928 a committee with Mr. C. Addams Williams, C.I.E., M.I.E., Chief Engineer to the Government of Bengal, was set up by the Government of Bihar and Orissa. Its recommendations were very insufficiently given effect to, on financial grounds. After the last devastating flood of August 1937, from which Orissa particularly suffered, the Government of Orissa approached Sir. M. Visvesvaraya through Mahatma Gandhi for tackling the problem of floods in the province. Sir M. Visvesvaraya recently submitted a preliminary note on this subject, which has been published by the Government. In this note, he makes a survey of the situation, repeats the findings of the 1928 Committee, and adds his own recommendations. He emphatically stresses the need of systematic investigation of the problem and of a comprehensive plan, and strongly recommends the establishment of a Flood Protection Board, composed of leading officials and representatives of the people.

The object of the remedial measures for the protection of a flood-afflicted area should be to train the rivers on their way to the sea by constructing protective embankments, judicious dredging, flood escapes, etc., by removing obstacles to floods, opening out estuaries and making cuts through sand banks leading to the sea, so that nowhere in the area affected may the floods exceed a reasonable depth, or remain too long to injure the standing crops. The problem should be considered for each river separately. The area affected by more than one river will require special examination and treatment.

The recommendations of Sir M. Visvesvaraya in these circumstances may be summarized as follows :

(*i*) Two competent engineers of the rank of Executive Engineer may be appointed for the preliminary investigation work needed. They should be given adequate subordinate staff and set to work in two divisions into which the entire affected area may be divided.

(*ii*) Their very first work will be the collection of data and essential information from past reports and records and also by local investigation, and printing the same in a concise, intelligible and attractive form.

(*iii*) It is necessary to conduct a systematic survey and collect hydraulic data, statistics of popula-

tion, production, and other information relating to the area liable to inundation along each river.

(*iv*) A committee of three expert engineers may be appointed as an advisory body to supervise the technical side of the work of the special staff and maintain a continuous study of flood problems.

(*v*) When a complete statement of new works and improvements necessary is prepared for each river along with the statistical information relating to the population, production, etc., the cost of the proposed works should be considered with reference to the population and interests protected, or in other words, in relation to their ameliorative value, and decision should be arrived at as to what works should be taken up for execution and what money it would be reasonable to spend on them.

(*vi*) Then should follow a general compilation of all the results of investigation including approximate estimates of cost of all the works proposed, so that Government may be able to decide, with the advice of an expert committee, if necessary, on a comprehensive plan and programme to be adopted and the total amount of capital to be expended on the measures as a whole.

(*vii*) After arrangements are made for financing the works, detailed estimates should be prepared for the various schemes one by one and arrangements made for their execution in the order of their urgency and importance.

(*viii*) The main point to decide is what capital and recurring outlay would be needed and how much money, having regard to their resources, Government would be justified in spending on progressive flood control both in the semiprotected and unprotected areas.

The question of improvement to the tract hangs on finance. Once that question is settled satisfactorily, the actual surveys, the preparation of detailed estimates and their examination and approval by experts will offer no serious difficulty. The organization for schemes and construction of works will follow automatically. When that stage is reached, the Government establishments will be found quite competent to take up the thread and carry forward the scheme to a speedy and successful conclusion.

Sir M. Visvesvaraya in conclusion makes the following observations which deserve careful and serious consideration:

"The Report of the 1928 Committee is valuable as a starting point. The first move in the furtherance of the Committee's work should be to undertake the preliminary investigations necessary, that is, investigations recommended by the Committee's report as well as those suggested in this note. When the investigations have made some progress and rough estimates of cost of proposals are ready the responsibility will devolve on Government to decide with the help of expert engineers what capital outlay to incur on the works and over how many years to spread such outlay, in other words to prepare a comprehensive plan and programme. Save such emergency works as may be needed to give immediate relief all new works undertaken should be in accordance with and form part of such a plan.

"The Committee have stated that no trace exists of any general enquiry into a discussion of the Orissa flood problem during the fifty years following Mr. Bénind's Report of 1872. Such a general enquiry is now overdue. It is an old engineering lesson which says that time and money judiciously spent in scientific investigations is a prime economy. So long as the methods adopted happen to be haphazard and unscientific, Government will not have full confidence in the efficacy of the measures they might undertake and the people inhabiting the areas will be always living in uncertainty and apprehension. If on the other hand the developments proceed on scientific lines after full investigation, the situation will clarify as time goes on, and whatever works are executed, whether small or large, will be fulfilling the intentions for a comprehensive plan. All parties will know where they stand and such funds as Government may be able to spare will be put to the best use.

"As the river bed levels will be rising and the river courses undergoing frequent changes the protection operations should also be modified to suit such changes. The investigations should not cease even after a plan and programme are prepared. The work should continue until the position of each river is more and more correctly understood and its behaviour more thoroughly mastered, until the river regimen becomes increasingly stable and more and more area is brought under protection, and until both the engineers in

charge of the developments and the people interested in them are able to foresee where the next heavy flood is likely to cause damage and be prepared with measure to minimize the loss.

" One remark should be added in conclusion. The situation should be faced with courage, the investigations should be constant and continuous until the flood menace is brought under some control. To my personal knowledge, during the past forty years the Indus river delta in Sind has greatly improved by such treatment. Mr. C. A. Bock, an American Engineer, writing in the " *Engineering News-Record* of May, 1932, says:

" ' There is great need for flood-control works in many places where the cost of protection is at the present time clearly beyond the resources of the community and where part protection would be inadvisable. The answer to these situations should not be one of hopeless abandonment, deliberate neglect or blind refusal to recognize the problem.'

" ' The three essentials for meeting this problem are publicity, planning and authoritative control.'

" He also adds in the same article: Huge sums have been wasted on flood-control works lacking comprehensive planning.'

" In a Government statement showing the effect given to the Flood Committee's recommendations it is mentioned that many of the proposals could not be undertaken either on account of the opposition of vested interests or lack of funds. *What is here suggested as an essential preliminary, is not costly words at once but investigation to place the whole* scheme of things on a scientific basis. The investigation work should be proceeded with and the comprehensive plan referred to should be prepared even if no thought is entertained of carrying out all the works that may be proposed in the near future.

" Construction must inevitably follow. Government should go to the limit of their resources to execute the plan, ensure progressive improvement of the tract and put confidence and hope into the people."

Research in Goat Pneumonia

A bad type of disease which has been of great concern to the goat breeders in India recently came up for investigation at the Imperial Veterinary Research Institute. This is the Goat Pneumonia, a disease chiefly observed during the lean months of the the year when grass and herbage are scarce. It is believed that dietetic factors control the incidence of the disease to a marked degree. Work on this disease at the Institute has been directed largely to an attempt to confirm previous opinion that the disease is of virus or bacterial origin. It has been found impossible to reproduce any type of the disease in healthy hill goats, which are peculiarly susceptible to inoculation experiments, by the inoculation either of filtered or unfiltered lung, pleural or mixed tissue extracts from diseased goats at various stages of the disease. Nor has it been possible to isolate in culture any predominating organism to which directly pathogenic properties can be ascribed. A histological examination of pieces of lung sent from several provinces where the disease is enzootic has not indicated a virus type of pneumonia. On the contrary, the opinion is expressed, the type is essentially verminous. It is believed as a result of observations made that contagious pleuro-pneumonia of goats is primarily a parasitic broncho-pneumonia, that most goats are potential victims of the disease, and that the acute terminal phase of the disease is determined by a break down of tissue resistance consequent on lowered vitality induced by malnutrition. Secondary organisms normally present in the respiratory tract are finally responsible for the spetic pneumonia which completes the syndrome.

New Palit Professor of Physics

Prof. D. M. Bose having taken leave for one year, with a view to join the Bose Research Institute as its Director, Dr M. N. Saha, Professor of Physics of the University of Allahabad, has been appointed in his place as the Palit Professor of Physics in the Calcutta University with effect from next July. At present the post is for one year, but the Calcutta University hopes to retain the services of Prof. Saha permanently.

Science in Industry

Production of Artificial Silk from Cotton

Production of artificial silk in the world is small compared to that of cotton, but its possibilities for expansion are great. Its cost is much cheaper than silk and about 30 per cent more than cotton. Owing to its cost artificial silk can compete for many purposes with mercerized cotton. India imports annually on an average over 80,000,000 yards of artificial silk and over 16,000,000 pounds of artificial silk yarn. In 1937 India imported 99,374,000 yards of artificial silk piecegoods, and 14,515,000 yards of artificial silk mixtures the largest imports ever made by this country. The import for artificial silk yarn for the same period was 17,628, 884 lbs. Between 70 and 80 per cent of the yarn is used by handlooms and the rest by power looms for mixed fabrics and fancy designs.

There are four processes of artificial silk making. These are the viscose process, the cellulose-acetate process, the nitro-cellulose process, and the cupro-ammonium process. Of these the first two processes are mainly employed to produce artificial silk fibre for commercial purposes. At present a very large proportion of artificial silk is manufactured by the viscose process, the United States of America topping the list of producing countries with Japan next. India produces enormous quantities of short staple cotton and there is a large surplus of it available in this country. The Central Cotton Committee, being interested in the possibility for uses of this cotton, proposes to instal a pilot plant for experiments which should give results more or less on an industrial scale. It the experiments with this new plant, for which a sum of Rs 30,000/- has been alloted, prove successful, a new use will be found for the surplus staple cotton available in India, to the great benefit of cotton-growers, workers and the industry in general.

Indian Sugar Manufacture

The Director of the Imperial Institute of Sugar Technology, Cawnpore, has drawn up a note on the efficiency of sugar production in India, covering the entire period of production from the season 1932-33 to the season 1936-37. In comparing figures for these seasons allowance should be made for two abnormal years. The season 1933-34 was affected by the Bihar earthquake of 1934, as a result of which several factories, as well as railways and roads were damaged in Bihar. The damage to the standing crop was not serious but it became considerably deteriorated by the time necessary repairs were made and the cane was crushed. During the next season, 1934-35, the cane crop in the Punjab and the western parts of the United Provinces was seriously damaged by attacks of pyrilla and other pests, followed by frost. The quality of cane, the note states, has improved as a whole. Fibre percentage of cane has increased. This is a defect from the point of view of milling, as it reduces milling capacity and increases losses in bagasse. The higher average fibre content appears to be due to more ratoon cane being supplied to factories and also to crushing being continued even after the cane is over-ripe and partially dry. Improvement in quality of cane is most pronounced in the Punjab, Sind and the United Provinces. Bihar does not show any improvement, but this may be due to the considerable increase in the crushing period.

No exact figures are available for the cost of cultivation of cane, but it is believed, that this varies between 3½ annas and 5 annas per maund exclusive of transport charges. On the whole there was an all-round improvement in the efficiency of manufacturing processes. But there is still scope for improvement as compared with some other countries. The principal by products of sugar factories were bagasse, press mud and molasses. Bagasse was exclusively used as fuel and very few factories had so far sufficiently large surpluses of this to require any special methods for utilization. Press mud had not received any attention as its principal use was to make manure, and the factories in Northern India were not growers of cane. Molasses was the most important by-product of the sugar industry and the considerable fall in its prices had meant a substantial addition to the net cost of production of sugar. On the whole it may be said

that there had been a general improvement in the quality of sugar manufactured in India with respect to colour and size of grain, but there was still considerable scope for improvement, specially in regard to reduction of mixed grain and poor colour.

Indian Paper Industry

The progress made by the paper industry in India under the scheme adumbrated under the Bamboo Paper Industry (Protection) Act, 1925, has fully justified the policy of discriminating protection sanctioned by the Government of India in 1925, says a Note submitted to the Tariff Board by the Imperial Forest Research Institute, Dehra Dun, on the present position of the paper industry and the possibilities of its future development. The Note points out that during the period 1924-25 to 1936-37 the production of writing and printing papers by Indian mills increased from 23,331 to 43,951 tons *i.e.*, by nearly 88 per cent. while imports of the "Protected" varieties decreased from 20,039 to 11,839 tons, *i.e.*, by nearly 41 per cent. The protection granted to the industry, therefore, has enabled the Indian mills not only to supply the entire increase a consumption of 12,420 tons of writing and printing papers of the "protected" class during this period, but has also enabled them to capture 8,200 tons, or about 41 per cent. of the foreign imports of these papers.

The balance of the imports, about 12,000 tons, consists of a large number of superior and special varieties of writing and printing papers. The manufacture of these has not hitherto been undertaken by the Indian mills partly because they have been occupied in capturing the expanding market of the ordinary grades of writing and printing papers, and partly because of the individual varieties was too small to permit their production on economic basis. The expansion of the writing and printing paper industry in India during the last 12 years has been based largely on the use of indigenous raw materials, *i.e.*, bamboo and grass which was stimulated as a result of the imposition in 1932 of the protective duty on the imports of wood pulps. In 1935, a conference of representatives from the paper mills of this country was convened in Calcutta by the Forest Research Institute with a view to co-ordinating research in bamboo so as to enable the industry to take advantage of the latest scientific developments for its healthy growth. Co-operative research on certain problems suggested at the conference is in progress at the Forest Research Institute, and this work is being helped in a small way by the paper industry itself, which now subscribes about Rs 4,000/- annum towards the expenses of the Paper Pulp Section at Dehra Dun.

The Note mentions that there is a vast scope for the manufacture of packing, printing, wrapping, newsprint cheap printing papers and boards of various kinds in this country. Experiments have, therefore, been initiated at the Forest Research Institute to explore the possibilities of manufacturing these papers and boards in India. Concluding the Note says, "The present world economic and political conditions require that India should be self-sufficient as early as possible, not only with regard to most of her needs for papers and boards but also as regards the supplies of cellulose and cellulose products which are assuming an increasingly important role in the economy of human progress and civilization, both in times of peace and war. While, as a result of the protection granted to writing and printing papers in 1925, the country is well-nigh self-supporting as far as these papers are concerned, she is still dependent on foreign countries for her requirements of newsprints and cheap printing and packing papers. Research is in progress to enable the manufacture of these papers to be undertaken in India in due course of time. "A re-adjustment of the tariff schedules for the import of mechanical wood pulps and old newspapers may, however, induce the establishment of mills for the manufacture of these papers in the immediate future. This would enable the country to have requisite plant and machinery for the supply of all her requirements of paper and boards and thus be prepared for an emergency. A reasonably liberal expenditure on research is in the long run more economical to the tax-payer than the indefinite continuance of protection or subsidy. In fact the provision for organised research ought to form a necessary part of any measure of protection granted to an industry.

Illimitable Deposits of Marble in N. W. F. Province

That the North-West Frontier Province is well supplied with excellent white statuary marble and has illimitable quantities of banded marble suitable for building purposes is the conclusion reached by

Dr Coulson in a paper published in Part 2 of Vol. 72 of the Records of the Geological Survey of India. He describes the occurrence of marble and dolomite at Ghundai Tarako, a hill forming part of the boundary between the Swabi tahsil of the Mardan district and the Buner tract Swat in the North-West Frontier Province and considers that the largest quantities of statuary marble will be found in the Ghundai Tarako. In a contribution made last year Dr Coulson described the marble occurrences of the Swabi tahsil and of Khyber Agency, and suggested that, to keep up a regular supply of first class statuary marble and to develop the marble industry in the province, it was advisable to develop simultaneously the Shahidmena, Kambela Khwar and Maneri deposits. Also every care should be taken, he said, to extract the less valuable, banded, relatively impure marbles at the same time as the pure white marble, which at all times will command a market. By doing so, large quantities of good quality banded marble, suitable for tiles, facing, and general building purposes, which would otherwise be wasted, would be available in addition to the statuary marble. These remarks, Dr Coulson urges, still hold good. He adds that careful selection of sites for development should be made, taking into consideration the type of stone required, and is of opinion that possibly the best sites will be found in the neighbourhood of the main peak on the Mardan side of the ridge.

Industrial Development of Bihar

The province of Bihar has under the new Congress ministry already made considerable progress in industrial development, and several new schemes are being planned in furtherance of this end. The main items on which the Department of Industries has centred its activities are, according to a pressnote issued by the Information Officer of Bihar:

(1) *Technical and Industrial Training*:

(*a*) Establishment and control of Government institutions for imparting technical and industrial training.

(*b*) Grants-in-aid to private technical and industrial institutions.

(*c*) Grant of scholarships and stipends for training in and outside the province and also in foreign countries.

(*d*) Imparting advice in matters relating to training of students.

(2) *Industrial Development*:

(*a*) Improvement of the industries by rendering technical advice and assistance.

(*b*) Propaganda and demonstration work in such industries which have prospects of development.

(*c*) Controlling institutes for handicrafts teaching; commercial organizations for the popularization and extension of markets of the products of cottage industries and participation in exhibitions and fairs.

(*d*) Development of fisheries.

(*e*) Financial assistance to industries—Administration of State Aid to Industries Act and the Rules.

(*f*) Preparation of industrial schemes and projects and carrying on industrial surveys as deemed necessary or justified.

(*g*) Development of simple improved appliances suitable for cottage workers.

(*h*) Industrial experiment and research.

(*i*) Collection, collation and dissemination of industrial intelligence.

The Survey Schools at Patna and Cuttack were reorganized, developed and improved—the former being now a full-fledged college of engineering offering teaching of civil engineering up to the degree course of the Patna University and the latter an uptodate engineering school teaching up to the senior deploma standard. The old industrial school at Ranchi has been developed into a technical trade school. Also a technical institute has been opened at Muzaffarpur. Besides, facilities for technical training, which did not exist for the boys of the province before, were made available to them by the liberal grant of scholarships and stipends in technical institutions and industrial firms outside the province. Under this scheme some 30 to 40 boys are regularly receiving technical and industrial training every year in various subjects. The Department of Industries is also said to be helping private efforts in providing industrial education by giving liberal grants-in-aid. At present more than 2,000 boys are in industrial training.

The development of cottage industries is receiving

close attention of the Government, and under the State Aid to Industries Act, the Department has redered financial assistance to several indigenous industrial firms. The Department has also under contemplation several schemes. Some of these which are likely to be brought into operation in the immediate future are (1)training of women workers of the Jharia coal fields in weaving and basket-making with a view to provide employment to those who will be discharged from under-ground work as a result of the new legislation passed by the Government of India ; (2) arrangement for higher training in mechanical and electrical engineering with a view to make qualified youths of the province fit for holding important positions in industries ; (3) installation of silk twisting plant at the Bhagalpur Silk Institute which is expected to give considerable impetus to the indigenous silk and tasar industry and (4) imparting training through peripatetic parties in the art of tanning and making of leather goods which, it is hoped, will become very important and prosperous cottage industry of the province. In addition to these there are other important and useful schemes which may be brought into operation if and when funds permit.

A New Cement Factory in Bihar

The opening ceremony of a new cement factory at Dalmianagar, Dehri-on-Son, Bihar, was performed by His Excellency Sir Maurice Hallet, Governor of Bihar on March 20 last. The factory owes its existence to the industrial enterprise of Seth Ramkrishna Dalmia, who in his address of welcome characterized his efforts as a mere drop in the ocean. He felt that much remained to be done, and visualized an era when India would not lag behind other countries in industrial progress.

This newly opened cement factory at Dalmianagar is claimed to be the largest single unit concern in India with a capacity for 500 tons. It is one of the long chain of seven more factories to be spread all over India, *viz.*, two in Madras, two in the Punjab, one in Gujrat, one in Sind and one at Dalmianagar. The total output of these factories will be 8,00,000 tons of cement.

Our Industrial Articles for April

"The Glass making Sands of Bargarh" by Mr M. L. Misra, and "Soft Coke and the By-Products" by Mr B. B. Niyogi, which appear below, form the articles of this section for our April issue.

The Glass-Making Sands of Bargarh

M. L. Misra
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The well-known sandstone beds occurring near Bargarh, 38 miles south of Allahabad, are the chief sources of supply of glass sands to all the glass factories in North India. Although the Bargarh sands are used in the glass industry in large quantities, little useful and scientific information is available about them excepting a few chemical analyses done in India and abroad. Considering the importance of these sands to the glass industry and the present state of our knowledge about them, it was thought desirable to study their occurrence in the field and their chemical composition and microscopic characters in the laboratory. The present communication contains the results of these investigations.

The sandstones occurring south of Allahabad first present themselves near the Jasra Railway Station and one finds a chain of sandstone quarries along the railway line between this station and Bargarh. The country is rocky and flat and from the general level of the flat surface low hills emerge out here and there. These sandstones constitute the lower portion of the Upper Vindhyan formation. They dip N. W. at an angle of 4 to 7 degrees and are interbedded at places with thin beds of greenish looking shales. The sandstone is massive and cultivation is carried on wherever it has been covered up by soil. Sometimes lateritic concretions are also seen to conceal the sandstone beds.

The sandstones are compact, and dirty white and light pink in colour. Amidst these compact sandstones are found incoherent masses of sand of irregular shapes and these are the places which are selected as sites for the glass sand quarries.

By the study of the sands at different quarries situated near Jasra, Lohgara, Shankargarh and Bargarh railway stations, it was found possible to divide these sands into three grades: (A) white, (B) dirty white, and (C) yellowish. Representative sands of each of the grades were analysed in order to confirm the three grades established in the field.

The results of the analyses are given in the following table. Other available analyses have also been included for the sake of comparison.

TABLE I.

	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Loss on Ignition.	Total.
1. (A)	97.69	1.72	.04	.28	Tr.	.54	100.27
2. (A)	98.24	1.23	.05	.40	Tra.	.30	100.22
3. (B)	96.9	1.63	.10	.54	Tra.	.49	99.66
4. (C)	97.23	1.04	.42	.31	.18	.55	99.73
5. (D)	96.3	1.53	.50	.49	.51	.51	99.84
6.	94.86	2.75	.15	.20	.59	1.0	99.55
7.	97.8	1.024	.086	.26	Tra.	.60	99.77
8. *	97.58	1.52	.16	Tra.	.18	.68	100.12
9. *	98.97	.51	.51	..	..	..	99.99
10. *	95.92	1.70	.90	.53	.24	.71	100.00
11. *	94.6	2.43	..	1.30	.87	.60	99.80

(The letters in the brackets denote the grade of the sand. Analyses nos. 1 to 7 have been done by the author, 2 and 6 are from Shankargarh. 1, 3 and 5 are from Bargarh. No. 4 is from Lohgara. No. 7 is of sand from Bargarh obtained by the Department of Glass Technology, Benares Hindu University.

Remarks on Chemical Analyses

Judging from the iron content of the sands it will be seen from the analyses that the best sands are Nos. 1 and 2 which contain about 98% of silica and about .05% of Fe_2O_3. The silica content in Nos. 4 and 5 is about 97% and Fe_2O_3 about .5% indicating the inferiority of these sands to Nos. 1 and 2. Analysis No. 3 occupies a position in between those two groups. In it the silica is 97% and Fe_2O_3 about .1%. Thus by looking at the table one can safely make out that the analyses are of three grades of sand. The analytical results, therefore, are in full agreement with observations made in the field.

*Report of the Tariff Board set up to enquire into the condition of glass industry, 1932, P. 20.

The analyses Nos. 7, 8, 9, 10 and 11 are of those samples of sand which are not collected from the field but are of samples of sand which have been received by different glass factories. They have been analysed by different persons for different factories. A comparison of these analyses with those done by the author shows that No. 9 compares favourable with No. 4, and No. 8 with No. 3. No. 10 is a fourth grade sand the samples of which the author did not collect. A study of these analyses shows that sand of A-grade does not reach any glass factory. The sand which is supplied to the Glass Department of the Benares Hindu University also falls in grade B.

Mechanical Analyses

100 gms. of each sample were taken and passed through different sieves:

No.	40 Mesh. (Retained.)	60 Mesh. (Retained.)	80 Mesh. (Retained.)	100 Mesh. (Retained.)	Passed through 100 Mesh.
1A	10.14	13.4	77.3	..	..
2A	5.0	10.4	84.6	..	..
5C	7.0	8.4	84.0	..	0.60
3B	8.2	9.8	80.6	1.2	..
4C	8.6	13.0	77.4	1.0	..

Description of Grains under Microscope

No. 2. The grains are mostly angular, their size is not uniform, as there are a few extra large ones. In the grains the iron does not seem to be uniformly distributed but appears to form a surface layer on a few grains only.

No. 1. The grains are of a more regular size and shape, and the angularity is much less marked than in No. 2, though the percentage of large grains is greater. The size of those grains is also bigger than that of No. 2. The distribution of impurities appears to be similar.

No. 5. The grains in this sample are more irregular in shape than in either 2 or 1, but there appears

to be considerably greater unevenness in size. Very large grains are few, while the iron contamination seems to be uniformly distributed over the grains. The angular and round grains perhaps are in equal proportion.

No. 3. The grains here are irregular in size and shape and the percentage of grains of larger size is greater than in any of the above samples. The grains are angular, but a considerable number are round. The contamination is more than that in Nos. 2 or 5.

Origin

It has been remarked above that glass sands occur as irregular patches here and there amidst compact sandstone and not as regular beds. It, therfore, necessarily follows that these sands have been derived from the compact sandstone by some process. In order to throw light on the origin of these sands from the parent rock, a section of compact sandstone was examined under the microscope and a sample analysed chemically. The chemical analysis is given in table I (No. 6). Under the microscope it was found to consist of rounded grains of quartz cemented together by ferruginous material. It has already been noted that the lateritic concretions cap the sandstone at various places in the field and that the colouring matter in the sands is only superficial. The natural conclusion from those data is that due to differential subaerial weathering of the compact sandstone its ferruginous cementing material has been leached out by surface waters leaving behind incoherent and loose masses of sand at places where conditions for weathering were more favourable. The iron-bearing solutions have also coloured the glass sands thus obtained by forming a superficial thin crust on sand grains after evaporation. A comparison of the analyses of the compact sandstone and of glass sands also supports this view. The iron content of the first and second grade is less than that of compact sandstone. C-grade sands contain more iron than the compact sandstone. The presence of higher percentage of iron in this case may very well be attributed to deposition of iron on sand grains after evaporation of the ferruginous waters. It appears that the removal of iron by surface waters is responsible for the formation of A-grade sand at one place and the same waters have coloured the good sand and thus rendered them inferior in quality at another.

Economic Considerations

At Shankargarh quarrying of compact sandstone is done along the hills. Gun-powder of local make is used for blasting. The sandstone is utilized for the purpose of ballast which is supplied to the railways. Some flagstone and millstone are also sent out from here, but no sand is quarried as such. Labour and quarrying are cheap and are done mostly on contract basis. 100 ft. of ready ballast is obtained for Rs. 2/-. The transport is cheap. The loose sandstone of this locality (No. 2) is not at all utilized for any purpose.

Quarrying at Jasra, Lohgara, and Bargarh is done in open pit system. The sandstone obtained here is friable and is easily quarried by hammer and chisel. Wooden hammers are used to convert it into sand, and no machinery is used to crush it. Sand is obtained at the quarry site at the rate of 20-26 tins of sand (each tin 2′ ×1½′ ×1½′) for a rupee. Transport is also cheap, *i.e.* annas 8 for about 25 mds. from quarry to the station. It may vary according to distance of the quarry from the station. About 2-3 wagons of sand per day are sent from Bargarh.

For the sake of comparison analyses of some notable foreign glass sands along with the analyses of the A-grade sands of Bargarh and Shankargarh have been tabulated below:—

	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Loss on Ignition.	Total.
* British (Lynn).	98.82	.56	.06	.16	.02	.33	99.95
* French (Fontainebeau).	99.5	.23	.03			.22	99.98
* Belgian	98.64	.63	.06	.31	.13	.12	100.34 (.45 alkali)
* German (Hohenbocka).	99.7	.35	.05			.10	100.2
* American (Berkley springs) W.Va.	99.65	.11	.02	.12	Tr.	.23	100.13
Bargarh No. 1.	97.69	1.72	.04	.28	Tr.	.54	100.27
Shankar-garh No. 2	98.24	1.23	.05	.40	Tr.	.32	100.24

As far as iron contamination is concerned the A-grade sands found in the area are in no way inferior to

*(Report of the Indian Tariff Board 1932.)

British, French, American, Belgian or German sands; on the other hand they seem to possess an advantage over them in containing a higher percentage of alumina.

It is a pity that this high grade sand does not reach the manufacturers of glass. Often it is "adulterated" with inferior sands in large quantities resulting in its degradation to B or C grades. And it is for this reason that the analyses done by Dr Turner and other notable workers correspond with those of B-and C-grade sands. If this A-grade sand is not allowed to be adulterated and a proper sorting is done in the field, best quality sand can be obtained from Bargarh and finest quality glass can be produced. The author is in agreement with the recommendations of the Tariff Board (which was set up to enquire into the condition of glass industry) relating to washing of sands. By proper washing, for which several methods and apparatus are now available the B- and C-grade sands can be considerably improved.

Soft Coke and the By-Products

B. B. Niyogi
Department of Chemistry and Assaying, Indian School of Mines, Dhanbad.

According to the Annual Report of the Chief Inspector of Mines during the year 1935, the quantity of coal used for coking purposes at the collieries was 1,370,403 tons, from which 890,547 tons of soft coke and 84,737 tons of hard coke were manufactured. The quantity of hard coke made at the collieries is small, for most of the hard coke is manufactured in coke-making plants, and over one and a half million tons of coal were despatched to different coke-making plants during the year 1935. While most of the coke-making plants have machinery and appliances for recovering some, at least, of the by-products, the manufacture of soft coke at the collieries follows a most primitive and wasteful method.

As has already been said, over a million tons of coal are burnt annually for the production of soft coke, and all the valuable volatile constituents are lost in the process. If recovery could be effected to the very moderate extent of only 10 gallons per ton of coal the quantity of tar oil yielded would be no less than ten million gallons per annum. This would ultimately yield at least five million gallons of petrol. The extent of the losses sustained by the industry and the country is, therefore, colossal. It would be doing injustice to the industrialists of India if we were to say that they are unconcerned about the interests of the nation. They are fully alive to the national and commercial advantages of successful treatment of coal at both high and low temperatures. But the difficulties they have to face are many and varied. To start with, there is the question of capital. With the present panicky state of the money market, the task of attracting capital for new and necessarily expensive ventures presents formidable, if not insurmountable, difficulties. Besides, the obvious technical difficulties which have to be faced in connection with the proper utilization of tar oils and other products recovered during the process of carbonization are sufficient to damp all enthusiasm.

Now that the process of hydrogenation has met with a considerable degree of success, particularly in Germany and the U. S. A., the question of utilization of the by-products from high and low temperature carbonization should be taken up. In view of the extensive consumption of liquid fuel in many of our industrial concerns, the conversion of tar oil and other by-products into fuel is now worth considering in India.

A few words on this process of hydrogenation, will, I think, not be amiss here. Petrol contains 85 per cent of carbon and 15 per cent hydrogen, whereas in coal or in coal-tar for the same amount

of carbon there is much less hydrogen. In the hydrogenation process coal or some coal-tar product is heated along with hydrogen to about 450°C in the presence of catalysts and under a pressure of 250 atmospheres (3,500 lbs. per sq. in.), so that the solid coal or the coal-tar is transformed nearly quantitatively into petrol and gaseous hydrocarbons. Hence the word "hydrogenation", indicating the addition of hydrogen and its chemical combination with the various coal substances. Low temperature tar contains between 85 per cent and 90 per cent of carbon and between 7 per cent and 8 per cent of hydrogen. It can be hydrogenated into petrol with a yield of between 80 and 90 per cent. This process can be applied not only to coal but to all mixture of hydrocarbons, such as tars and mineral oils. Another application of the process is that of converting poor lubricating oils, heavy petrols, cracking petrols, etc. into analogous oils of the best quality. Though the process, which may be said to be unique in the history of modern industry, has incalculable potentialities, yet it has at present its own peculiar drawbacks. The construction of high pressure plants for large-scale working, the inevitable heavy depreciation, the production of cheap hydrogen and the supply of heat for the operation are some of the difficulties that have to be faced.

Already Germany and the U. S. A. have made very rapid progress in this direction. The Leuna Hydrogenation Plant in Central Germany was erected in 1927 with a capacity for the production of 30,000,000 gallons of petrol per annum. In 1930 a production figure of 43,000,000 gallons was reached, and later the production rose to 45,000,000 gallons. Some time ago the I. G. Farbenindustrie of Germany and the Standard Oil Co. of New Jersey joined forces for hydrogenation of coal and oil, and formed the Standard I. G. Company for controlling the process in Germany and the U. S. A. Recently, another company, the International Hydrogenation Patents Co., has been formed to cover the rest of the world. Very lately hydrogenation plants have been erected in Great Britain under the management of the Imperial Chemical Industries Ltd. and there is no doubt that India will be benefited by the experience of that Company. I refer, of course, especially to the well-known plant at Billingham.

At the formal opening of the plant by Mr Ramsay MacDonald in October 1935 Sir Harry McGowan in the course of his speech referred to the history of the development of the process as follows regarding the Coal Hydrogenation Plant at Billingham-on-Tees:—

"The plant is now working, as you will shortly see. We have had a number of teething troubles, which always accompany the starting up of new and complex chemical manufacture. I am glad to say, incidentally, that the difficulties which have so far arisen have been all overcome, and I have no doubt we shall be able to cope successfully with any others that emerge. To date we have converted 11,000 tons of coal into petrol, and the total amount of petrol that we have so far produced both from coal and creosote oil, and low temperature tar is 40,000 tons. We began naturally by hydrogenating tar oils, and came slowly to handling the more difficult coal. Its introduction, however, has progressed smoothly and rapidly. By the beginning of next year we anticipate reaching full flow sheet rate of production from both materials."

A satisfactory solution of the problem of the coal industry in India is intimately connected with the manufacture of soft coke on scientific lines and the utilization of the by-products. We shall have to introduce both carbonization and hydrogenation, for they must supplement each other. In order to obtain the possible result we must recognise their limitations, both economic as well as commercial. Once we realize this and act upon it, we shall have progressed far on the way to solving India's Coal Problems.

Research Notes

A further Note on the Heavy Electron

It was mentioned in my article on the Heavy Electron (*Sc. & Cul. 3*, 5, 257-61) that there could exist other fundamental particles apart from the wellknown electron, positron, proton, neutron and the still hypothetical neutrino. Examples were given as to the possibility of existence of anti protons and antineutrinos and also particles having masses and charges comparable to these particles but obeying a different statistics from all these, that of the Einstein-Bose statistics. In this connection was mentioned the possibility of the existence of electrons obeying the Bose-Einstein statistics and a prediction of its mass given by Yukawa to be approximately fifty times that of the ordinary electron. The interest awakened by these hypothetical particles led to a search for them and interesting evidence was obtained by Street and Stevenson and Anderson and Neddermayer from the examination of cosmic ray showers which pointed to a particle having a mass intermediate between those of the proton and electron and having a charge equal to that of the electronic charge. Neddermayer and Anderson obtained a track, a photograph of which was reproduced in the previous article, which showed an ion density along its track much greater than that of the electron and an He value from the curvature of the track in a magnetic field which gave a mass intermediate between those of the proton and electron. The mass could not be accurately determined but the estimate was that it was from 50 to a 100 times that of the ordinary electron. Street and Stevenson carried out similar experiments with a view to obtain the heavy electron track in the Wilson Chamber sufficiently near the end of its range to measure its curvature accurately. To eliminate electrons obtained from the cosmic rays they used a lead block between two Geiger counters so that only fast particles and not the shower electrons would come into the Wilson Chamber. Another counter was placed below the chamber. The fast particles whose tracks would not end in the chamber would pass through the lower counter also. The electrical circuit is so arranged that when all the counters count, the chamber does not operate. It operates only when the electrical particle passes through the counters on the top of the chamber but not through the counter below, ensuring thus a proper photograph of a track very near the end of its range. With such an apparatus Street and Stevenson took about 1000 photographs of tracks and obtained one track which did not seem to be that of a proton or electron. To facilitate the measurement of the loss in energy in the passage through the chamber a drop-count was made by taking photographs one second after the particle had passed. This allows for a diffusion of the ions before the drops are formed and makes it easier to count the individual drops. The track which Street and Stevenson could not attribute to the proton or electron had a curvature in the magnetic field corresponding to He = 9.6×10^4 gauss$\times$cm. The length of track within the chamber is about 7 cm. Assuming a proton gives us an energy of 4.4×10^5 eV which would allow for only 1 cm track length, we can conclude immediately the particle is at least 7 times lighter than that of the proton and probably even less. Allowing for the qualitative nature of the experiment the particle whose charge is negative, has a mass between 7 and 10 times less than that of the proton.

Another interesting piece of evidence regarding these particles comes from the observations of Bothe and others on the cosmic ray showers at the Kaiser Wilhelm Institute, Heidelberg. They found that the showers produced by the cosmic rays are not all similar in nature. One type of shower different from the usual ones, had greater penetrating power and diverged at a very small angle ($\theta = 7°$) from the point of its origin, while the ordinary showers ($\theta = 30°$) had a widely diverging angle. The intensity of these showers varied

with the substance, according to the Atomic number Z of the shower producing matter, whereas in the ordinary shower, it is proportional to Z^2. The hard shower seems to be produced exclusively by the hard component of the primary cosmic rays, and though the hard cosmic rays seem to be able to produce the soft shower, the soft components of the cosmic rays do not seem able to produce the hard shower. It has been suggested that the hard component of the cosmic rays as well as the hard showers are heavy electrons. This suggestion can explain some of the facts mentioned above, *e.g.*, greater penetrability. The rest of the facts may be explained when the production of showers by heavy electrons is dealt with theoretically.

As far as the experimental evidence goes the heavy electron is fairly well established, the only objection being that so far only a few tracks have been obtained and measured so that the probability of an error in the determination of its mass remains high until more tracks are measured.

B. D. Nagchowdhury.

Influence of Animal Hormones on Plant Growth

Recent workers on the influence of animal hormones and plant growth have tested a number of substances. Hávás and Caldwell found that the action of hormones varies with the concentration of hormone. Davis recorded earlier flowering in Narcissus and Allium after treatment with thyroxin. Niethammer found a stimulatory effect of thyroid extract on opening buds of various dormant shoots and on germinating seedlings.

Budington found greatly decreased growth in roots of Narcissus and Allium grown in nutrient solution containing thyroid extract. He assumed that the freshly growing tissues of the root were comparable to those in larval amphibia, which would respond to dosage with thyroid extract by precocious development of tissues, and suggested that thyroid caused precocious development in both.

If a comparison of plants and amphibia is legitimate it is interesting to note that Thompson and Huxley record retarded growth in axolotes resulting from treatment with parathyroid hormone. Such comparison indicates a similarity in the response of plants and animal protoplasm to certain hormones. E. D. Brain (*Ann. Bot. 1*, 615, 1937) recorded the results obtained by him when seedlings were grown in dilute solutions of parathyroid and thyroid hormones. The hormone preparations used were Paine & Byrne's Ltd., "Pabryn" brand. The parathyroid solution contained 20 Collip units per c.c. The thyroid solution was standard solution prepared from fresh gland. The seeds were germinated and then placed with the roots dipping into water to which small quantities of the hormone solution were added. Controls were grown in distilled water.

The author finds that decrease in length of roots was marked in *Avena Sativa* in parathyroid solutions and in *Phaseolus multiflorus* in thyroid solution.

Experiments with radishes and *Avena Sativa* seedlings treated with thyroid solution indicate that a dilute solution may stimulate growth though a stronger one may retard it.

H. N. B.

University and Academy News

Biochemical Society, Calcutta

The 30th General Meeting of the Biochemical Society, Calcutta was held on Thursday, February, 17, in the lecture room of the All India Institute of Hygiene and Public Health under the chairmanship of Prof. H. Ellis C. Wilson. The following papers were read:--

(i) P. N. Sen Gupta and B. C. Guha--Estimations of total Ascorbic acid in food materials.

(ii) K. C. Saha and B. C. Guha—Fermentative production of citric acid from molasses.

(iii) S. N. Mukherjee-Protein fractions of oedema fluids in epidemic dropsy.

Altogether 33 members were present and each of the papers was keenly discussed.

The Secretary, Dr S. N. Ray on behalf of the society bade farewell to Dr H. E. C. Wilson, a founder member and a member of the executive committee and to Dr D. L. Shrivastava, one of the present secretaries, both of whom have got new appointments outside Calcutta. He thanked them for the services they had rendered for the cause of the society. Dr Wilson gave a suitable reply.

Institution of Chemists (India)

An ordinary meeting of the Institution of Chemists (India) was held on the 26th February 1938 in the Chemical Lecture Theatre of the University College of Science, Calcutta.

Mr N. N Sen Gupta, President, was in the chair.

The following papers were read and discussed:—

(i) A. Ghosh—On the Methods of Denaturing Spirit in India for Industrial and Domestic Purposes.

(ii) S. Ranganathan and H. K. Sen—Injection Moulding of Shellac Plastics.

(iii) N. N. Murty and H. K. Sen--Fluorometric Determination of the Acid and Saponification Values of Lac.

The National Academy of Sciences, India

A meeting of the National Academy of Sciences, India, was held on the 11th February, 1938 in the Muir College Buildings, Allahabad. Prof. B. Sahni, F.R.S., President of the Academy, was in the Chair.

The following papers were read and discussed:--

1 B. N. Sen--On a Photo-chemical theory on Photo-electric Threshold.

2. B. N. Sen On a Physico-chemical theory of Ionization of atoms on the basis of strain.

3. B. N. Sen On the Distance of the closest approach of atoms.

4. B. N. Sen--Parachor and Velocity of sound in Metallic elements.

5. B. D. Pant and R. R. Bajpai—Study of F region Ionization at Allahabad.

6. Jagraj Behari Lal -Chemical Examination of the Fruits of *Physalis Peruviana* or Cape Goose Berry, Part III.

7 B. D. Toshniwal—Soil constants at Ultra High Frequency.

The annual function of the National Academy of Sciences, India, was held on March 5, 1938 at 3 P. M. in the Vizianagram Hall. Pandit Jawahar Lal Nehru presided over the function. The additional items for this year's programme included a scientific exhibition and a conversazione on Power Supply in the U. P. in which a number of distinguished authorities on the subject took part.

Book Review

Annual Bibliography of Indian Archaeology, for the year 1935. *Published by Kern Institute, Leyden, pp. i-xii, 1-161, pls. I-XIII. Price 6 guilders or Rs. 6/ . E. J. Brill Ltd., Leyden, 1937.*

In this admirable and indispensable work an attempt has been made to present a complete bibliography of Indian and Greater Indian archaeology for the year 1935. In the foreward the learned editor-in-chief has expressed his indebtedness to financial and scholastic help received from the respectable quarters. This work may be divided into three sections, *viz.*, (1) Introduction, (2) Bibliography, and (3) Index.

The main idea for the incorporation of the first section *i.e.*, Introduction, in such a work is to pubiish articles, on the important archaeological discoveries in different countries, written by well-known archaeologists. The following articles are included in this section. In the article entitled "The work of the Archaeological Survey of India during 1934-35" Rao Bahadur K. N. Dikshit has briefly reported the work of the Archaeological Survey of India in 1934-35 and speaks of the recent archaeological discoveries at Rangpur, Taxila, Gokul, Baigram, Mahanad, Nalanda, Kilpauk, Hathi-bara and Hmawza. In the section entitled " Archaeological news in notes " various interesting archaeological finds have been referred to, among which the recent excavations at Chanhu-daro, Rangpur, Kumrahar and Lauriya Nandangarh should be specially mentioned. In the subsection entitled " Museums " special mention has been made of the recent work entitled " Museums of India " by Messrs. S. F. Markham and H. Hargreaves. In the subsection entitled " Forthcoming publications " the author has rightly put emphasis on the book entitled *The monuments of Sanchi* by J. Marshall, A. Foucher, N. G. Majumdar and H. Hargreaves. In the section entitled " Indian Numismatics in 1935 " Sir R. Burn has made editorial comments on those articles which he considers to be important. In the section entitled " Publications relating to ancient Indian geography " Dr B. C. Law attempts to give a bibliography of ancient Indian geography. In the section under " Excavations at Chanhu-daro in 1935-36 " Mackay has given an account of the archaeological excavation at Chanhu-daro by the joint expedition of the American School of Indic and Iranian Studies and the Boston Museum of Fine Arts. In the section entitled " The Lahore Fort, its history and restoration" Mr H. L. Srivastava gives a very interesting account of the Lahore Fort from its foundation by Akbar the Great up to the modern age when it has been completely restored to its former structure. In the section of " Archaeological work in Hyderabad-Deccan " Mr G. Yazdani gives a short account of the archaeological work done in Hyderabad among which special mention should be made of the discovery of a large rock-cut Brahmanical temple at Bhokardan in Aurangabad district in Hyderabad. In the section entitled " The Archaeological Department of Baroda State " Mr H. Sastri gives a short description of the excavation work carried out at Amreli, Mula-Dvaraka and Kamrej. In the section entitled " Excavations at Gyaraspur, Gwalior State " Mr M. B. Garde gives an account of the archaeological excavation at Gyaraspur which is situated 23 miles north-east of Bhilsa. In the section entitled " Epigraphical discoveries in Ceylon during the year 1935 " Mr S. Paranavitana has reported that in this year the Archaeological Survey of Ceylon secured estampages of 205 inscriptions of which the great majority are pre-Christian Brâhmi records. In the section entitled " Archaeological work in Burma during the year 1935-36 " Mon. C. Duroiselle gives an interesting account of the archaeological work carried out in Burma during the year 1935-36. The most important discovery is a terracotta plaque depicting a party of musicians in purely Indian style found at Kyantu in Pegu district. In the article entitled " The exploration of Śri Deva "

BOOK REVIEW

Mr H. G. Quartich Wales gives a very interesting account of the exploration of the ancient city of Śrî Deva (modern Si Tep) situated in the Pasak Valley of Central Siam. In the section entitled "Discovery of the sacred deposit of Angkor Vat" Mon. G. Coeds gives a very detailed account of the sacred deposit of Angkor Vat. In the section called . "The Asram Maharasei" Mr H. Mangir gives a detailed account of this temple in Indo-China. In the article entitled "Progress of archaeological work in Netherlands India in 1935" Mr F. D. K. Bosch gives an account of the prehistoric, Hindu, Moslem and Dutch antiquities. In the article entitled "Two recent publications on Iranian archaeology" Mr J. H. Kramers reviews Herzfeld's "Archaeological history of Iran" and Stein's "An archaeological tour in the ancient Persia."

In the bibliography section books and articles numbering approximately 832 have been reviewed after they are classified under different groups. There is an excellent author index. There are 12 plates illustrating the most important archaeological finds of the year

This is an excellent work but there are certain points where the present reviewer wishes to offer some suggestions. Firstly, it seems that the title of this work should be changed. This work is called *Annual Bibliography of Indian Archaeology*; but as it deals not only with archaeology of India but also with that of Ceylon, Further India, Indonesia, Iran, Mesopotamia, Turan, Afghanistan, Tibet, China, Japan and Korea from the standpoint of the cultural expansion of India as evidenced by archaeological testimony, it becomes apparent that this title does not properly indicate the scope of this work. A very apt term called "Greater India" has been recently coined to indicate those places where Indian culture has profoundly influenced the course of their individual cultures. Therefore the present reviewer suggests that the title of this work should better be changed into "Annual Bibliography of Indian and Greater Indian Archaeology." Secondly, it seems that more attention should be paid towards the inclusion of articles written in Indian languages in the bibliography. Thirdly, it seems that this work is published a little bit later and thereby loses some of its importance. The present reviewer hopes that the Kern Institute will publish it a little earlier.

However the present work has kept the reputation of its former numbers and is indispensable to all who are interested in Indian and Greater Indian archaeology.

C. C. Das Gupta.

A TEXT BOOK OF PRACTICAL PHYSICS, by *Dr S. Dutt. Published by Chuckervertty, Chatterji & Co., Ltd., Calcutta, pp. 1-257, July 1937. Price Rs. 3/8 -.*

The book is the second edition which has been revised and enlarged upon the first one. The chief feature of the book is that at the end of each section the author has given a number of exercises and test questions to help the student in understanding intelligently the principles of the experiment and to enable him to form an idea of the nature of the oral questions asked during practical examinations. The introductory chapter is useful as it gives general instructions with regard to graph plotting and degree of accuracy of observations and results. The theory of almost all experiments described is explained clearly. There are, however, certain omissions to be noted in this revised edition. For example in the experiment with spectrometer the adjustments with the gauss Eyepiece are not described. The use of the potentiometer for finding the internal resistance of a cell is not dealt with. In the case of a telescope the variation of its magnifying power with distance when the object is at a small distance from it is not given. In the experiment described on p. 164 for determining the focal length of a lens by the plane mirror and the optical bench the formula of conjugate distances from the focal planes and its application for measuring the focal length of a combination of lenses are not mentioned. Lastly the theory of the ballistic galvanometer and its use for the determination of absolute capacity of a condenser, the self and mutual inductances, the theory and method of finding the wave length of light by spectrometer and diffraction grating would have been valuable additions in this revised edition.

A table of useful physical constants is given as an appendix at the end of the book, but the logarithmic and trigonometrical tables have been unfortunately omitted.

B. C. Das.

Introduction to Optics, *by G. B. Deodhar, Ph. D., F. Inst. P., Senior Lecturer in Physics, Allahabad University. Published by the Indian Press Ltd., Allahabad.*

The book is an outcome of the author's lectures delivered to the B.Sc., students in the Allahabad University. In addition to the conventional treatment of Geometrical and Physical Optics there are also chapters on spectroscopy, absorption and transformation of radiation, meteorological optics, colour phenomena and photometry and a description of the ether-drift experiments. In the appendix are given some useful data on refraction and wavelength together with a list of useful physical constants.

The author has succeeded in putting together in a single work a larger amount of information than may be had from any other single book on optics. Absence of mathematics is a feature which may not recommend itself to all. The descriptive part, however, is quite satisfactory. The inclusion of many recent theoretical and practical developments helps to bring the reader up to date, but he is held back for want of proper references. These might have been given with profit.

The book, as the author states in the preface, is intended to offer a comprehensive background to those who wish to specialise in optics, as well as to those who are anxious to have a general knowledge of the subject. He has succeeded in the latter purpose; but in view of the absence of mathematics it is to be doubted whether the background offered is to be considered comprehensive.

On the whole the work is to be welcomed for its wealth of information and may be recommended to the honours students of Indian universities.

D. P. Ray Chaudhuri.

Drugs and Galenicals. Their Quantitative Analysis, *by D. C. Garratt, B.Sc., Ph.D., F.I.C., Drug Analyst, London County Council. With a Foreword by Sir Frederick Menzies, K.B.E., M.D., LL.D., F.R.C.P., Cloth; 6×9; pages xiv+422. Chapman & Hall, Ltd., London. 1937. Price 25s.*

This book is not intended as a textbook for students of pharmaceutical chemistry, as the theoretical explanations are not sufficiently simple and complete. The book is mainly intended for workers in the field of pharmaceutical analysis, who are often confronted with the analysis of compounded preparations containing official substances. The author has contributed, from his long practical experience as an analyst, various hints and suggestions for helping one to carry out the estimation of official substances and their preparations. Valuable material on the chemical analysis of drugs, scattered throughout the extensive literature, has been compiled by the author after experimentally trying himself many of the published methods.

The manner of presentation is pleasing and easy for reference, the general scheme adopted being that of the British Pharmaceutical Codex. Separate sections are allotted to Fixed Oils and Fats and Essential Oils. There are twelve useful appendices at the end of the book. The book would be a very useful addition to the libraries of the pharmaceutical concerns and those of the analysts who may be sometimes asked to analyse compounded preparations. The reviewer recommends this book to the notice of even the experienced analysts in the public health laboratories of India.

M. L. S.

Letters to the Editor

[The Editor is not responsible for the views expressed in the Letters]

Utilization of Jute Waste for Hessian-making

The jute fibre, as sold in the market, remains hard and stiff at the lower end up to a height of about 9"-12", due to the presence of various cementing materials which bind together the best fibres, as these cannot be removed by the ordinary process of retting. This causes a huge waste, amounting to several thousands of maunds per day, as this portion of the fibre cannot be utilized for the purpose of manufacturing hessian. This portion is generally used for manufacturing low-grade gunny bags, which do not fetch the proper price of the jute. In order to utilize this rejected portion for manufacture of hessian, we undertook some research work in our laboratory and have been successful in obtaining very good results by the use of a certain bacterium, which very readily removes the hard portion of the fibre, without in any way affecting the quality or the strength of the fibre itself.

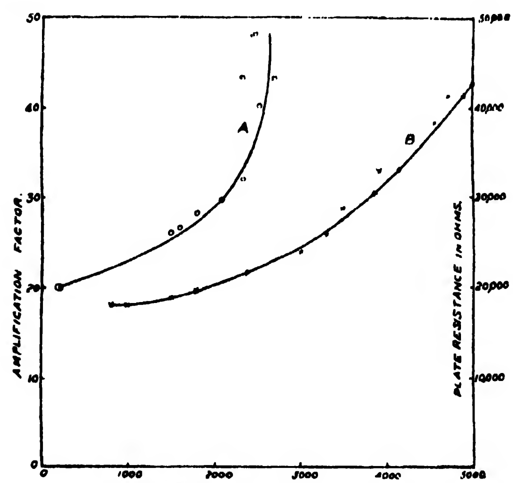
Department of Applied Chemistry, University College of Science, Calcutta.
B. C. Ray.
P. B. Sen.

23. 2. 38.

Variations of the Amplification Factor and Plate Resistance of Thermionic Valves at High Frequencies

The amplification factor and the plate resistance of a thermionic valve are the two important constants involved in the determination of the performance of a valve amplifier. Attempts have therefore been made by various investigators to find the variation of these constants with the plate and grid voltages and also with frequencies. Hartshorn [1, 2] has shown that the resistance of the thermionic valve at very high frequencies should be smaller than that at fairly low frequencies. Mitra and Sil[3] on the other hand have shown that the resistance of the grid-plate space in a thermionic valve increases at high frequencies but remains constant below the frequency of 8 megacycles per second. Tuttle[4] has found that the amplification factor and the plate resistance of a valve at audio frequency tend to change simultaneously in the same sense.

Though the variation of the plate resistance at high frequencies has been studied by various investigators the variation of the amplification factor which partly depends on plate resistance seems to have not yet been studied at high frequencies. The present note contains the result of our study of the variation of the amplification factor and the plate resistance with considerable large range of frequencies from 120kc/sec to 5,000kc/sec. A modification of Miller's method has been employed for finding the amplification factor at high frequencies. The usual audio oscillator of Miller's bridge was replaced by a Hartley type valve oscillator which was inductively coupled through an intermediate tuning circuit to the bridge resistances. The headphones were replaced by a low resistance sensitive mirror galvanometer along with a vacuo thermo junction. The resistance of the plate-filament space of the valve was measured by direct substitution method.



The curves A and B in fig. 1, show the variation of the amplification factor and plate resistance respectively with frequency. It will be observed from these curves that both the constants increase simultaneously with the frequency.

The amplification factor increased from a value of about 20 to 45 when the frequency was altered from 120 kc/sec to 2750 kc/sec. The resistance of the filament-plate space varied from a value of 18,000 ohms to a value of 42,500 ohms for a range of frequency from 120 kc/sec to 5000 kc/sec. There is not much appreciable change in the resistance up to a frequency of 1250 kc/sec as will be observed from the curve B.

LETTERS TO THE EDITOR

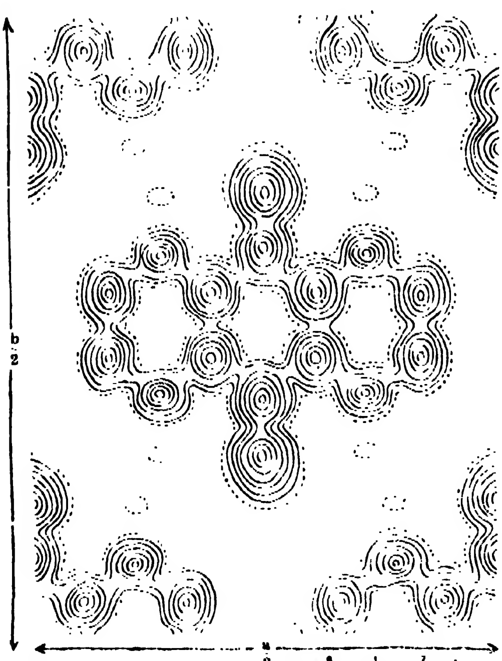
The authors have great pleasure in thanking Prof. P. Dutta, M. A. (Cantab) and Dr S. S. Banerjee for their interest and constant help in the work.

Physics Department, Benares Hindu University.
R. D. Joshi,
R. G. Saxena.
21. 2. 38.

[1] Hartshorn, *Proc. Phys. Soc.*, *41*, 113, 1928.
[2] Hartshorn, *Wirel. Eng.* *8*, 415, 1931.
[3] Mitra and Sil, *Phil. Mag.*, *13*, 1081, 1932.
Tuttle, *Proc Inst. Rad. Eng.*, *21*, 857, 1933.

Electron Density Map of Anthraquinone

A map of the projected electron density on the (001) plane of anthraquinone crystal has been obtained by the method of the two-dimensional Fourier Analysis. For that



Fourier projection along C-axis. Contours at intervals of one electron per Å². The one electron contour is dotted.

purpose a Weissenberg photograph for the equatorial layer line was taken for rotation about the *c*-axis of the crystal. The relative integrated intensities were obtained by an adaptation of the Zeiss Microphotometer. For absolute intensities, a few lines of the substance were compared by the Zeiss Microphotometer with the lines of rocksalt in a powder photograph of a mixture of rocksalt and anthraquinone. The signs of the Fourier terms were determined from a preliminary determination of the structure by the trial and error method. A very useful guidance for the trials was obtained from a pseudo-symmetry observed in the planes of reflection, *viz.*, that of all the *hko* planes, only planes with even values of h and k for which $h+k$ is divisible by 4 gave reflections of measurable intensity. The a and b axes of the unit cell were each divided into 48 parts and after carrying out the Fourier summation, contour lines were drawn through points of equal denstiy at intervals of one electron per square Angstrom unit. The contour map is shown in the figure. The determination of projections on the other two planes is in progress.

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Space-Group of Methylene Amino-Acetonitrile.

The pure substance CH_2NCH_2CN was crystallized from alcohol. From goniometric measurements the crystal was found to belong to the orthorhombic system with the following axial ratios

$$a : b : c = 1.489 : 1 : 0.6877$$

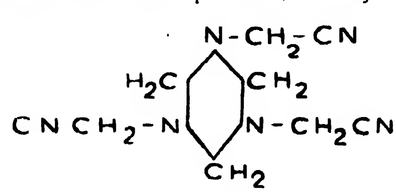
From rotation photographs about the three crystallographic axes, the axial ratios were found to be

$$a_0 = 15.20 \text{A}^\circ,\ b_0 = 10.21 \text{A}^\circ,\ c_0 = 7.021 \text{A}^\circ$$

and hence the number of molecules per unit cell was calculated to be 12.

From oscillation photographs it was observed that the *hol* planes for which $h+l$ is odd are absent. There was no other systematic absence of reflections.

Since the molecule CH_2NCH_2CN cannot have any symmetry element the orthorhombic bipyramidal class is precluded, on the other hand the absent planes do not conform to any space-group corresponding to the sphenoidal class. Hence it is concluded that the space-group is C_{2v}^7 $P\nu\mu$ and three molecules form one asymmetric unit. Tentatively a model is given below of three molecules of CH_2NCH_2CN forming a ring. To decide this point measurements of magnetic susceptibilities as well as intensities of X-ray reflections are taken up in this Laboratory.



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SCIENCE AND CULTURE

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Development of Cattle and Dairy Industries of India

AT the invitation of the Imperial Council of Agricultural Research, Dr Norman C. Wright, Director of the Hannah Dairy Research Institute, Scotland, visited India during the cold weather of 1936-37, and his report on the development of the cattle and dairy industries in India recognizes the special nature of India's problems and suggests a radical change in outlook on the part of the Government in this respect.

Milk is now considered by experts on nutrition as an essential protective food, and it is held that for the maintenance of satisfactory growth and health, about 20 oz. should be taken daily by an individual. The output of milk in India is estimated at 6,000 million gallons a year which only gives 7 oz. as the average *per capita* consumption per day. The need for increased production and avoidance of wasteful methods in the handling of milk is obvious. For many decades to come, the available milk supply of India may not be sufficient for internal consumption according to modern dietary standards. In planning the development of the dairy industry, therefore, it is essential to ensure that it caters for the existing needs and dietary habits of the population.

It is unfortunate that the present provision for instruction and research in dairy industry should not only have been inadequate but should have been devoted to Western dairy products whose consumption in India is insignificant compared with those of indigenous products. Indian dairy institutes should study "first the fundamental difficulties involved in handling milk under tropical conditions and the special problems associated with the lack of adequate communications and transport facilities" and "of knowledge of hygienic methods." Indian dairy methods may have to be greatly modified from those employed in temperate zones. Processes, for heat treatment, refrigeration, cheap methods of loose milk delivery, formulation of reliable methods of analysis and satisfactory standards of purity, effective checks on adulteration—these are some of the problems which should receive immediate attention.

In India, the production of *ghee* (clarified butter) must be looked upon as the most important single factor in any scheme for the development of dairy industry. Far more milk is utilized for *ghee* manufacture than is used for liquid consumption. Yet we have not evolved satisfactory standards for grading *ghee*, nor have the methods of modern science been applied to its manufacture. As a first step in this direction an attempt should be made to establish grading centres in the *ghee* producing areas under the Agricultural Produce Act of 1937.

DEVELOPMENT OF CATTLE AND DAIRY INDUSTRIES OF INDIA

Apart from liquid milk and *ghee*, the most important dairy products of India are *khoa* (solidified milk) and *dahi* (curd). It is desirable that the nutritive value of these indigenous products should be carefully investigated in view of their widespread consumption. The problems of desiccation of milk under Indian conditions require careful study, as there is clear indication that the market for milk powder may considerably be expanded and as there is the possibility of substituting *khoa* of poor keeping quality by this powder. Study of the bacteriological processes associated with the production of *dahi* may also yield results of considerable commercial significance.

It is suggested that the existing Imperial Dairy Institute should be transferred to a more suitable site in the *ghee*-producing areas of northern India, and should be reconstituted as an Imperial Dairy Research Institute. Under a very well qualified director, the work of the Institute should be divided into four sections, *viz.*, dairy bacteriology, dairy chemistry, dairy technology, and dairy husbandry. Side by side with the development of this Research Institute, efforts should be made to encourage the investigation of dairying problems at provincial agricultural colleges. There might be specific difficulties associated with the manufacture of dairy products peculiar to a province, and it is best that these problems are tackled locally. Training for the Indian Dairy Diploma should be given at the provincial agricultural colleges, and not at the Central Research Institute which may only provide research training and refresher courses. "If improved methods for the production and handling of milk and the manufacture of milk products are to be made use of in the villages, it will be essential to have available a large number of workers trained in certain elementary dairy practices. Courses of training for such works should also have to be provided at provincial agricultural colleges. It is recommended that serious consideration be given to the provision of dairy training for women."

India possesses nearly one-third of the world's cattle population, but, owing to unsatisfactory management, the production value of the cattle industry is not at all commensurate with its size. Indian milk products may be estimated at 300 crores of rupees; hides and skins may be valued at 400 crores of rupees, and the monetary value of cattle labour applied to Indian agriculture may be estimated at 400 crores of rupees. Considering the enormous value of this industry, it must be admitted that very little attention has hitherto been paid to the development of this industry. In view of the need for increased production of milk, which should at least be doubled in order to maintain a healthy population, the problem of cattle-breeding should be taken up on a comprehensive scale. Breeding experiments carried out at various centres show that by careful selection indigenous strains of Indian cattle can be built up, which are capable of giving milk yields comparable with those found among the average European stock. It is essential that the breeding of high-yielding strains should be quickly extended. The number of bulls at present as studs represents only one per cent of India's requirements. Material progress can only be achieved by rapidly increasing the number of approved and registered stock raised in villages, and private breeders. Simultaneously with the progress in the distribution of pedigree bulls, there should be intensification of castration measures for eliminating the scrub bull. "In formulating breeding policies, two essentials must be kept in mind: first, the necessity for adopting a policy which will meet local requirements; and second, the need for continuity in the programme for breeding."

The majority of Indian cattle are seriously underfed, and there is no adequate provision for protection against epidemic diseases. Efforts at improved breeding will produce results of little value if the problems of cattle nutrition and cattle diseases are not satisfactorily solved. It appears that Western rationing systems are not suitable for application to Indian cattle and buffaloes. It is therefore desirable that suitable systems of rationing should be devised for the guidance of milch-cattle and bullock owners. In India, due to a non-uniform distribution of rainfall, adequate supply of fodder crops in rainless months is a serious problem. Again, the ordinary coarse fodders show a marked deficiency in the amount

of protein. Large scale attempts should be made to grow fodders of outstanding value such as beseem (Egyptian clover) and lucerne, and preserve them by silage formation. For studies in cattle nutrition, full use should be made of existing provincial research centres, *viz.*, Lyallpur, Dacca, and Coimbatore, as well as of the newly established Animal Nutrition Section of the Imperial Veterinary Research Institute at Izatnagar. The Imperial Agricultural Research Institute at New Delhi should undertake a comprehensive programme of analysis of fodder and feeding stuff.

Considerable progress has been made in recent years in the development of methods for combating rinderpest. The Imperial Council of Agricultural Research now maintains in each province a Disease Investigation Officer, who is responsible for the field-survey of the major cattle diseases in the province. It is urgently necessary, however, to improve and expand the organization for the effective dissemination of knowledge of diseases acquired at research centres as well as control of breeding and livestock management. It is strongly recommended that in the interests of both efficiency and economy, all these types of work should be unified in each province under a single department of animal husbandry. Success will ultimately depend upon a large staff of "Stock men" who should be trained to work among cultivators in the villages after obtaining special elementary courses of instructions in the veterinary and agricultural colleges.

The present measures which are designed to improve the general standard of Indian cattle are extremely inadequate. It is to be hoped that in each province there will be set up a board of rural development which would co-ordinate the activities of the departments of agriculture, animal husbandry, forestry, public health services and the co-operative societies. The popular ministries in the provinces can do no better constructive work than setting up an efficient board of this type provided with adequate funds to look after the needs of the rural population.

But, on the ultimate analysis, prosperity can be attained in the rural areas if only the economic value of the small agricultural holdings can be considerably increased. At present, India is virtually attempting to maintain a relatively dense human population by methods only applicable to an extensive system of farming. Such methods may be suitable for newly developing countries like Australia where ample land is available for each cultivator. In India there are 200 persons per square mile, and in the more fertile tracts, even 600 per square mile. With such dense populations, it is essential that the output of produce per acre should be high, and for the purpose the fertility of the soil must be maintained at a very high level. The development of Indian agriculture demands the dovetailing of the arable and animal husbandries into one mixed farming system. The cattle problem thus dominates the whole situation. Such a mixed farming system would involve not only the application to the soil of all available manure but also the cultivation of leguminous fodder crops which contribute markedly to soil fertility. The Indian village can only revive if along with intensive cultivation of cereal and money crops, the development of the cattle industry and a rational system of growing leguminous fodder crops find an important place in all programmes of rural reconstruction.

The Intelligent Man's Guide to the Production and Economics of Electrical Power

(Continued from the last issue)

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The Price of a Unit of Electricity

We now perceive that the price of a unit varies widely and depends upon the use to which it is put. When used for power purposes (that is, for driving machinery) the rates are lower, and depend upon the amount of units consumed. In London the rates for power vary from $\frac{1}{4}d$ to $\frac{1}{2}d$ and in Calcutta from $\frac{1}{2}$ anna to 1 anna. The charges per unit for domestic use are high, and vary in England from $1.25d$ (in Hampstead) to $3\text{-}4d$ in country districts. In Calcutta the price per unit is 2 annas and in Allahabad 3.75 annas.

The Use of Electricity

Let us now see the proportion in which electricity is used for different purposes. In an industrial country, the domestic load falls far short of the industrial load. For example, in Soviet Russia out of a total production of 25,000 million units in 1935, 69.6% was consumed in industry, 14.5% for domestic and municipal use, 2.2 for traction of electrified trains, and the rest 13.7% was lost in transmission and transformation. Even in England, the domestic load including domestic heating does not exceed about 20% of the total production of electrical energy. The industrial load forms a more certain factor, while the domestic load is at its peak only for a few hours in the course of the whole day. For this reason the charges for industrial use are low. Besides this, we have to remember that a country's industrial progress is hampered much if the charges for power supply are high. In Europe, it has been estimated that the power charges in industry on the average form only 3% of the total cost of production. According to the rates prevailing in India the charges are probably 9 to 12 per cent of the total cost of production. This shows, therefore, how far industries in India are handicapped in their development on account of absence of a cheap power-supply.

For industrial use, the rates are generally not much above the cost of production, *e.g.*, at Allahabad, the cost of production is .35 anna per unit, while the Municipality gets electricity for raising water at .72 anna; sometimes the industrial rates are fixed even lower than the cost of generation. The loss is compensated from the domestic consumer for whom electricity is considered as an item of luxury. This practice which is very largely followed by supply companies in this country has however been found to be harmful as in the long run it checks the growth in electrical consumption for domestic use. Below we quote from a paper read by J. A. Sumner before the Institution of Electrical Engineers on the 19th February 1937, which shows the disadvantages due to maldevelopment of domestic rates.

(1) "Prices for domestic supply are generally too high to permit of the extensive use of electricity and reductions in price tend to follow an increased demand, instead of preceding it. As a result the domestic load continues to be restricted, the fixed charges per unit sold remain high and a condition of expanding demand with consequent falling costs becomes impossible of achievement. This is particularly true for undertakings, supplying less than ten million units per annum.

(2) "Electricity for power purposes is sold in many cases at charges which are unremunerative and which are

considerably below the equivalent of cost of production by private plant. The effect of this is to place on domestic charges a burden which prohibits the domestic load from increasing to the point at which its inherently *high diversity** makes it profitable. This applies chiefly in the case of larger undertakings".

(3) "The absence of a unified tariff basis and a unified scale of charges for electricity causes anomalies and inequalities which have a psychological effect in deterring consumption".

Problems of Rate Calculation

The problem of rate calculation is therefore a complex one, and cannot be dealt with in detail in a general article like this. The arguments given above may be true for a country which has almost reached the saturation point in the development of industries. But for a country like India where industrialization, in its true sense, has not yet commenced, the arguments fail to materialize. In order to encourage the development of industries some preference has to be given. Agriculture requires even more beneficent reduction as the prices of grain in these days have gone down. Unfortunately, in the United Provinces, the Ganges Canal Hydroelectric Scheme which is meant to supply electricity for irrigation to agriculturists has not been able to supply electricity at a cheap rate on account of the unusually high production cost. The scheme therefore has proved to be a burden rather than a boon (contrary to the claim put forward by its sponsors) to the rural population of the western districts of the United Provinces.

Factors Governing Cheap Generation and Distribution of Electrical Energy

The problem of production and distribution of electricity is a very complex business, and the economies depend upon a large number of factors. Often solution of one set of problems gives rise to others of a more complicated nature. These however depend upon the particular plant and its economic situation. In this section an attempt has been made to discuss a few general factors which govern the rates for electrical power supply.

It has already been mentioned that electrical energy can be produced from coal, peat or lignite, oil, shale, wood etc. The cost of production per unit, therefore, depends to some extent upon the cost of these raw materials. In the case of water-power, this item of expenditure is saved, but instead of this a large amount of additional capital has to be sunk on the initial outlay of the plant in construction of dams, weirs, pipe lines etc. The construction of a hydro-electric station requires more skilled labour than a coal or an oil plant. Often *the saving in the cost of fuel is thus more than compensated by the interest and depreciation charges which have to be incurred on the additional capital.* The relative advantages of the two types of stations are dependent on the type of water power available and the proximity of the steam station to a coal field. It may be mentioned here that even near the Niagara falls (U. S. A.), steam-plants are competing quite successfully with hydroelectric plants. This argument has been given here only to remove from the reader's mind the false notion about hydroelectricity. It is often wrongly thought that in the case of water-power, energy is obtained without cost. This idea is absolutely false. The modern coal-burning plants which use high pressure steam have attained great efficiency in these years and only 1.5 lbs of coal are necessary to produce a unit of electricity, while 30 years ago, the figure was six times as great. The cost of coal alone per unit would therefore amount to .05 anna at Calcutta and about 1 10 anna at Allahabad in normal times.

But the cost of fuel forms only a small part of the total cost of production. We have also to take into account the interest on the capital investment, on machinery, building, etc. A large amount has also to be spent on distribution lines. To this we have to add the charges for depreciation of the machinery, establishment charges, and repairs. Finally, the price per unit would be determined by load factor. The following example will serve as an illustration. In India the cost of installing a steam plant is about Rs 450/- while in England, it varies from £20 to £40,

* "Diversity" means the multifarious uses to which electricity can be put.

including costs on transmission lines, per kilowatt installed. The cost of an average Hydel station in India, not started under Government auspices *e.g.*, the Cauvery Works, the various Tata Works, is about Rs 600/- per Kw. Suppose we want to construct a plant having a total capacity of 5,000 Kw. The initial capital required should not exceed Rs (5,000×450) = Rs 22,50,000/-. The recurring expenditure will consist of (1) 4% interest on the capital, (2) 3½% for maintenance and other contingencies, and (3) 3½% for depreciation of the machinery. The total running expenses per year therefore come to about 11% of the initial capital, which for the above plant would come to Rs 247,500/- annually. Let us now suppose that the plant works on an average load factor of 40%, which means that during the whole year it produces (5,000×.4×24×365) = 17,520,000 (17 million) units of electricity. As has already been mentioned above 1.5 lbs. of coal (best variety) are required for the production of one unit. The amount of coal required annually would therefore be (17,520,000×1.5)/2,240 = 12,000 tons. For a city like Allahabad the price of coal is about Rs 10/- per ton. Hence for producing 17,520,000 units a total of Rs (247500+120000) = Rs 367500/- would be required. The average cost per unit would therefore amount to $\frac{367500 \times 16}{175,20000}$ annas or about $\frac{32}{100}$ annas. It is evident that for a higher load factor the cost would come down still further.

The South Tons River Scheme

We can compare this cost with that of a hydroelectric station. Take the case of the proposed South Tons River Scheme, which is meant to supply electricity to certain rural areas in Allahabad, Mirzapore and Benares districts. The scheme is estimated by Sir William Stampe to cost Rs. 880/- for each installed kilowatt, and will have a total generating capacity of 7500 Kw. Taking the average load factor of 40% which we think is an overestimate the total production of units per year would be (7500×.4×24×365) = 26,280,000 KwH. Let us suppose that the interest, maintenance and depreciation cost the same as for the steam plant, the total annual expenditure would be 11% of the total capital, *i.e.*, about Rs 594,000/-. The cost price per unit would therefore be $\frac{666000 \times 16}{26,28,000}$ = about .44 anna which is nearly 50% higher than the cost for a steam plant. This is however an underestimate as we have neglected the loss of power which will occur in the transmission of electrical energy at high voltage through a distance of about 100 miles. These facts therefore prove clearly that for a place like Allahabad, a modern steam plant run by *longhaul* coal from Bihar or Bengal would be more economical than the proposed scheme of Sir William Stampe.

In fact, for a Hydel station, it is rather difficult to estimate the final cost per kilowatt installed. Nearly all the constructions needed have their own difficulties, and much depends solely on the ingenuity and skilfulness of the engineer in making the best use of the money. In India, the cost of hydroelectric plants has varied between rather fantastic limits. While in the Government scheme at Mundi (Punjab) a sum of Rs 3,800/- per kilowatt installed was spent, the famous Sivasamudram Hydel Works in the Mysore State cost only Rs 500/- per kilowatt. The United Provinces Upper Ganges Canal hydro-electric grid has been constructed at the cost of Rs 1204/- per Kw. This shows that schemes started under Government lead have been very much ill-conceived and ill-executed. In England a sum of £50 per Kw is considered too high for a hydroelectric station. On account of such huge expenditure many of these schemes have failed to furnish the consumers with cheap electricity. The high cost is mostly due to technical inefficiency. Many schemes have failed to return anything due to gross underestimation of the cost of construction and overestimation of the load factor. The importance of the load factor in determining the cost of production has already been mentioned.

An important item of expenditure is the money spent on transmission lines. Very few localities are fortunate enough to be situated in the neighbourhood of a water fall or a coal-field.

THE INTELLIGENT MAN'S GUIDE TO THE PRODUCTION AND ECONOMICS OF ELECTRICAL POWER

The power has to be transferred on wires. Hence, the further away consumers are from the plant, the higher will be the capital required for transmission lines. The cost of transmission of power along wires has been reduced in these days due to transmission on high voltage and the reduced price of transmission machinery. In such high voltage lines a considerable amount of power is lost specially when the load factor is heavy.

For Hydel stations, long distance transmission is necessary as there is no other way of transferring energy from the power station. In the case of an area situated near a coal field, it may be argued that the cost of transmission of energy from the coal field may be greater than the cost of transport of coal. This however is not true and it can be easily seen that the transport of electricity between two stations is much cheaper than the transport of coal when the distance is not much larger than 100 miles. The cost of electrical transmission for 100 miles along wires in England is approximately .02 *d* per unit inclusive of line losses and all other overhead charges, and the cost of transport of coal for the same distance is 9*s* per ton inclusive of end charges. If it is assumed that 1.3 lbs of coal are required for one unit the cost of transport of one unit would come to .06 per cent which is 3 times the cost of transmission of electricity on wires.

When a large number of generating stations are to be constructed, *i.e.*, when a definite plan has to be made for electrifying a part of the country, as in the English grid system, we have to take into account the relative advantages of constructing a few large stations spaced widely over a large number of small stations thickly situated. It is a well established fact that the bigger a plant the more economical it is. In fact the construction of big turbo-generators has been responsible for the cheap generation and development of electricity. The most suitable way of distributing electricity in a country is to construct regional stations (suitably situated) and interconnecting them by means of a grid so that in the event of a station running short of demand, it may be supplied with power from other stations having surplus power, but in constructing the grid care has to be taken that an unduly high sum is not spent on transmission alone. The grid system has obtained from the available resources:

Summary

To summarize: the following few points must be considered carefully if cheap power is to be obtained from the available resources:

(1) The approximate load required. This will depend upon the economic situation of the generating plant, *i.e.*, upon the type of consumers within the economic distance of the station.

(2) The economic possibilities of the region, *i.e.*, whether there are any chances of a future increase in the consumption of energy through development of new industries.

(3) Whether any hydroelectric resources capable of generating a larger power than required are easily available.

(4) If local hydroelectric stations are not available, whether it will be cheaper to install stations by using long-haul coal and other types of fuels or to have long distance high voltage transmission lines from the hydroelectric station.

(5) If several stations are to be constructed in forming a grid the relative advantages of widely spaced large stations over a large number of small ones, must be taken into account.

The Power Resources of India

In India, only the eastern parts, the Damodar basin, the basins of some Orissa rivers are in possession of good quality coal. Some inferior type of coal is also found in the Central Provinces and the Hyderabad State. The other parts of India have to depend either on coal transported from these parts (technically called '*long-haul coal*') or on their water power resources. Unfortunately

the latter has been surveyed to a very little extent and the total water-power developed comes to only about 500,000 (half a million) kilowatts. This, according to Sir M. Visvesvaraya, forms only 2 to 3% of the hydroelectric power available in the country. It must be added however that the power resources of India have never been surveyed satisfactorily and the above figures are only guess-works. It is quite probable that the figures quoted above fall far short of the actual resources, as was found in the U.S.S.R. Before the Soviet came into power, the water power resources were estimated at 14 million Kw, but after the careful investigation by the Power Research Institute set up by the central government it was found that the actual amount was 280 million Kw, *i.e.*, twenty times greater. At any rate even on the basis of the present imperfect surveying, India possesses sufficient water power to electrify her to the extent to which countries like Japan and Italy are electrified. What is urgently needed now is proper survey and devising of proper means for the harnessing and utilization of these resources. Only Bombay (the various Tata hydroelectric works) (Sivsamudram Hydroelectric Works) and Madras (Madras Pykara Scheme) have tackled a part o. their difficulty by partial development of their water power. The other provinces (the Punjab and U. P.) are also following, but the progress is very slow, and, owing to mishandling, has so far gone on entirely wrong lines. For details of the different schemes in India the reader is referred to *The Hydroelectric Practice in India*, by Prof. B. C. Chatterji.

The above considerations, therefore, clearly point out that if the problem is to be seriously tackled several preliminary surveys have to be undertaken of which the following are the most important:

(1) Hydrological and Geological survey of the basin, from which water supply is obtained with a view to find out whether there is a proper head or whether storage reservoirs are to be constructed.

(2) An economic survey of the region to be supplied with power to find out if it will consume the electricity produced; if not, whether fresh industries can be profitably developed, which utilize the power produced.

(3) If a region is economically and technically suitable for electrification, provision should be made for the supply of expert labour and the necessary materials in the country.

With regard to the first two points, our information is that no proper technical or economic survey has yet been made in this country with the result that almost all the power is running to waste. As regards the third point it is known to everybody that no factory (worth the name) exists in India which can manufacture the machinery required for the purpose. The Government of the country, while placing orders, has never taken the trouble of stipulating with the foreign companies that they should train Indians in techni cal work in their *factories*.

Every Indian, irrespective of his political creed, agrees, at least in one thing, *viz.*, that the problem of unemployment can only be solved if a planned system of industrialization is resorted to. But has anybody seriously thought over the various handicaps which are impeding the practical realization of these ideas. In our opinion the reason is simple. At the present time India has a great dearth of technically equipped persons, and even now, no steps are being taken for imparting technical education to the masses. In some provinces, the syllabus for primary education includes a little training on the technical side of agriculture, but that is not the thing required for our salvation. What we need is proper training to run small rationalized cottage industries. But this too cannot be started suddenly as there are very few persons for imparting this kind of training in India. It is therefore necessary to send batches of young men to countries like Italy, Japan and Switzerland which have specialized in manufacture through rationalized cottage industries. This practice had been adopted by all the countries who have grown recently. Japan,

although so highly equipped, even now sends a large number of young men to other countries to get themselves acquainted with the art of manufacture.

It is true that in the beginning the products of our newly started industries may fall short of in quality as well as in price, and for this they will require beneficent legislation and protective tariffs etc. which may gradually be withdrawn when the necessary experience has been attained. In the end, we have to bear in mind that the corner stone of success of these cottage industries would be in the supply of cheap power only through well planned electrification schemes.

Hindu Mathematics

(Continued from the last issue)

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Geometry

It is said that geometry originated in Egypt, near about the second millennium before Christ, in connection with land survey. The Greeks who learnt the science from the Egyptians, carried it to a very high degree of perfection. Hindu geometry commenced at a very early period, in connection with the construction of altars for Vedic sacrifices. In course of time it outgrew its original purpose and was cultivated for its own sake also. Indeed, there is no doubt that the study of geometry as a science began first in India. The early Hindu geometry was much in advance of contemporary Egyptian or Chinese geometry. Though the Hindu achievements in geometry were completely overshadowed by the success of the Greeks at a later stage, "it should never be forgotten that the world owes its first lessons in geometry not to Greece, but to India." In fact, the early Hindus obtained many interesting and ingenious results, results which are generally attributed to the Greeks but which should be credited to the Hindus. In their treatises, the ancient writers have not left any proof or demonstration of the propositions discovered by them. Only the bare results are left recorded.

The Pythagorean Theorem

The *Śulba sûtras* are the earliest geometrical works of the Hindus. The following results are either expressly stated or implied in the various constructions found in them:

(1) The diagonals of a rectangle bisect each other. They divide the rectangle into four parts two and two (vertically opposite) of which are equal in all respects.

(2) The diagonals of a rhombus bisect each other at right angles.

(3) An isosceles triangle is divided into two equal halves by the line joining the vertex to the middle point of the base.

(4) The area of a square formed by joining the middle points of the sides of another square is half that of the original one.

(5) A quadrilateral formed by the lines joining the middle points of the sides of a rectangle is a rhombus whose area is half that of the rectangle.

(6) A parallelogram and a rectangle on the same base and within the same parallels have the same area.

(7) The square on the hypotenuse of a right-angled triangle is equal to the sum of the squares on the other two sides.

(8) If the sum of the squares on two sides of a triangle be equal to the square on the third side, then the triangle is right-angled.

Theorem (7) above has been stated by Baudhâyana (c. 800 B.C.) in the following words:

"The diagonal of a rectangle produces both areas which its length and breadth produce separately.[21*]

Âpastamba[22] and Kâtyâyana[23] give the above theorem in almost identical words. The theorem is now universally attributed to the Greek Pythagoras (c. 540 B.C.) though "no really trustworthy proof exists that it was actually discovered by him.[24] The Chinese knew the numerical relation for the particular case $3^2+4^2=5^2$, probably in the time of Chou-Kong (died 1105 B.C.). The Kahun Papyrus (c. 2000 B.C.) contains four similar numerical relations, all of which can be derived from the above one. As for the Hindus, one instance of that kind $39^2=36^2+15^2$, occurs in the *Taittirîya Samhitâ*[25] (about 2000 B.C.). It should be noted that this instance is different from that known to other early nations.

Although particular instances of the theorem are found amongst several ancient nations, the first enunciation of the theorem in its general form occurs first in India. It is not improbable that Baudhâyana possessed a proof of the theorem. But what this proof was will never be known with certainty. Bürk, Hankel, Thibaut and Datta are of opinion that Baudhyâna knew a proof of the theorem.[26]

Quadrature

The Hindus studied geometry mainly with a view to its applications. Thus they devoted attention to finding formulae for areas, etc. For finding the area of the circle the Hindus gave several values of π. In the *Śulba sûtras* we find the values

$$\pi=4/\{1+\tfrac{1}{3}(\sqrt{2}-1)\}^2=3.0883\ldots\ldots$$

$$\pi=4\left\{1-\tfrac{1}{8}-\frac{1}{8.29}-\frac{1}{8.29.6}+\frac{1}{8.29.6.8}\right\}^2$$

$$=3.0885\ldots\ldots$$

$$\pi=4(13/15)^2=3.004\ldots\ldots$$

In 499 A.D., Âryabhata I determined an extremely accurate value of π which was better than all the Greek values:

$$\pi=\frac{62,832}{20,000}=3.1416$$

The value $\pi=\sqrt{10}$ is due to the Hindus and is first recorded in the *Sûryaprajñapti* (sûtra 20). It also occurs in the *Tattvârthâdhigama sûtra*[27] (c. 150 A.D.). Âryabhata's value of π was improved upon in the fifteenth and sixteenth centuries.

Brahmagupta made some very remarkable contributions to the properties of an inscribed convex quadrilateral. If Σ denote the area and m, n the diagonals of an inscribed quadrilateral whose sides are a, b, c, d, then his results are:

(1) $$\Sigma=\sqrt{(s-a)(s-b)(s-c)(s-d)},$$

where $2s=a+b+c+d$.

(2) $$m=\sqrt{\frac{(ac+bd)(ab+cd)}{ad+bc}}$$

$$\sqrt{\frac{(ac+bd)(ad+bc)}{ad+bc}}$$

[21*] *Baudhayana Sulba*, i. 48.

[22] *Apastamba Sulba*, i. 4.

[23] *Katyayana Sulba*, ii. 11.

[24] Health, *History of Greek Mathematics*, *I*, 144f

[25] *vi.* 2.4.6; it occurs also in the *Satapatha Brahmana x.* 2, 3, 4.

[26] See Datta, *The Science of the Sulba*, Calcutta, 1932, *ix.*

[27] *Tattvarthadhigama sutra*, iii. 2.

Rational Figures

The Hindus made use of their knowledge of indeterminate equations to propose and solve a variety of problems concerning the sides and areas of plane figures. And thus they applied their algebra to geometry.

The earliest attempt to obtain right-angled triangles having a given side is found in the *Śulba*. In particular, we find two such triangles having the sides (a, $3a/4$, $5a/4$) and (a, $5a/12$, $15a/12$). Brahmagupta (628) proposed to find all right-angled triangles having the side a and the other sides *rational*. His solution is

$$a,\ \tfrac{1}{2}\left(\frac{a^2}{n}-n\right),\ \tfrac{1}{2}\left(\frac{a^2}{n}+n\right)$$

Mahâvîra[28] (850) also gives the above solution. Bhâskara II has found another solution

$$a,\ \frac{2na}{n^2-1},\quad n\left(\frac{2na}{n^2-1}\right)-a.$$

Similar results occur for finding all right-angled triangles having a given hypotenuse.

Mahâvîra proposes and solves the following problems:

(1) "In a rectangle the area is numerically equal to the perimeter; in another the area is numerically equal to the diagonal. What are the sides in each of these cases)[29]?

(2) Find a rectangle of which twice the diagonal, thrice the base, four times the upright and twice the perimeter together equal the area numerically[30]?

(3) The perimeter of a rectangle is unity. Tell me quickly, after calculating what are its base and upright[31]?

(4) Find a rectangle in which twice the diagonal, thrice the base, four times the upright and the perimeter together equal unity.[32]

(5) Find all isosceles triangles with rational integral sides and areas.[33]

(6) Find two isosceles triangles whose perimeters, as also their areas, are equal or related in a given proportion.[34]

(7) Find all rational scalene triangles.[35]

(8) Find all triangles having a given area.[36]

Brahmagupta has shown how to find an isosceles trapezium whose sides, diagonals, altitude, segments and area can all be expressed in rational numbers.[37] He further formulated the following remarkable proposition:

Find all quadrilaterals which will be inscribable within circles, whose sides, diagonals, perpendiculars, segments, areas and also the diameters of the circumscribed circles will be expressible in integers.[38]

Solutions of the above have also been given by Mahâvîra, Śrîpati, Bhâskara II and others. Finally Mahâvîra has given the solution of the following remarkable problem:

Find all rational triangles and quadrilaterals inscribable in a circle of given diameter.

Trigonometry

The science of trigonometry is said to have originated with the Greek Hipparchus (*c.* 140 B.C.). But the Greeks used the chord of the angle instead of the sine or cosine functions. The chord of a given arc, which corresponds to the side of a certain polygon inscribed in a circle naturally attracted more the attention of a race of geometers. The function *sine* is in reality an invention of the Hindus. The change from the chord of an arc to the semi-chord may appear to be simple, but the first conception of this change did not come easily as will be realized by the fact that it did not occur to the Greek mind. The modern term *sine* is itself derived from Hindu sources. The Sanskrit term for the function is *jyâ* or *jîvâ*. The early Arab writers adopted this term and called it *jîba*. This latter term was subsequently corrupted in their tongue into *jaib*. The early Latin translators of the Arabic works, such as Gherardo of Cremona (c. 1150) rendered it as *sinus* which means "bosom" or "bay." The Hindu term for the cosine was *koti-jyâ*, often abbreviated into *ko-jyâ*. When *jyâ* became *sinus*, *ko-jyâ* was naturally rendered as *co-sinus*.

[28] *Ganita-sara-Samgraha, vii.* 97.f

[29] *Ibid, vii.* 115.

[30] *Ibid, vii.* 117.

[31] *Ibid, vii.* 118.

[32] *Ibid, vii.* 119.

[33] *Ibid, vii.* 108. Given also by Brahmagupta, *l. c., xii*. 33.

[34] *Ibid, vii.* 137.

[35] *Ibid, vii.* 110. Given by Brahmagupta, *l. c.*, xii. 34.

[36] *Ibid, vii.* 160-62.

[37] Brahmagupta, *l. c., xii.* 36.

[38] *Ibid, xii.* 38.

The Hindus used three functions of an angle, namely *jyâ, koti-jyâ* and *utkrama-jyâ,* which correspond respectively to our modern sine, co-sine and versed sine functions.

The study of functions of complements or supplements of arc is a contribution of the Hindus to trigonometry. Mañjula (932) states;

"The *jya* is positive or negative in the quadrants above or below (the prime line; and the *koti* is positive, negative, negative and positive successively."

The Hindus knew trigonometrical formulae corresponding to the following:

(1) $\sin^2\theta+\cos^2\theta=1$,

(2) $\sin(\theta/2)=\frac{1-\cos\theta}{2}$,

(3) $\sin(\alpha\pm\beta)=\sin\alpha\cos\beta\pm\cos\alpha\sin\beta$,

(4) $\sin^2 2\theta+\text{versin}^2\, 2\theta=4\sin^2\theta$,

(5) $\sin(45^\circ\pm\theta)=\frac{1\pm\sin 2\theta}{2}$,

(6) $\sin(\alpha-\beta)/2=\frac{1}{2}\{(\sin\alpha-\sin\beta)^2+(\cos\alpha-\cos\beta)^2\}^{\frac{1}{2}}$

Of the above the first three were also known to the Greeks; the fourth was stated by Varâhamihira (505); the remaining two are due to Bhâskara II.

The Hindu astronomers were also acquainted with the following formulae of spherical trigonometry:

$$\cos c=\cos a\cos b+\sin a\sin b\cos C,$$
$$\cos A\sin c=\cos a\sin b-\sin a\cos b\cos C,$$
$$\frac{\sin a}{\sin A}=\frac{\sin b}{\sin B}=\frac{\sin c}{\sin C}$$

Every Hindu treatise on astronomy contains a table of sines and versed sines as also of their differences, calculated for the angle 3¾° and its multiples. In this connection we have the following formula given in the *Sûrya-siddhânta* (c. 400):

$$\sin(n+1)\theta-\sin n\theta=\sin n\theta-\sin(n-1)\theta-\frac{\sin n\theta}{225}.$$

The above formula is used for calculating the table of sines. It depends on the calculation of their second differences. Delambre thought it to be curious and remarked: "This differential process has not up to now been employed except by Briggs who himself did not know that the constant factor was the square of the chord or of the interval, and who could not obtain it except by comparing the second differences obtained in a different manner . . . Here then is a method which the Hindus possessed but which is found neither amongst the Greeks nor amongst the Arabs."[39]

Series:[40] Finite Series

Series of numbers developing according to certain laws have attracted the attention of people in all times and climes. Arithmetic as well as geometric series are found in the Vedic literature of the Hindus (*c.* 2000 B.C.). The Hindus must have obtained the formula for the sum of an arithmetic series at a very early date, but the exact date is uncertain. It is, however, definite that in the fifth century B.C. they knew how to sum an arithmetic series, for in the *Brhaddevatâ* (500–400 B.C.) we find the result:

$$2+3+4+\ldots+1000=500499.$$

In the *Kalpa-sûtra* of Bhadrabâhu (*c.* 350 B.C.) the sum of the following geometric series

$$1+2+4+\ldots+8192$$

is correctly given as 16383, showing that the Hindus possessed some method of finding the sum of a geometric series in the fourth century B.C.

The following results:

(1) $\frac{n(n+1)}{2}=\sum_{1}^{n} r$,

(2) $\frac{n(n+1)(2n+1)}{6}=\sum_{1}^{n} r^2$,

[39] Delambre, *Histoire de l'Astronomie Ancienne, I,* Paris, 1817, pp. 457-62.

[40] For details and references see Singh, *Osiris, I,* 606-628.

(3) $$\left\{\frac{n(n+1)}{2}\right\}^2=\sum_{1}^{n} r^3,$$

(4) $$n\left\{a+\frac{n-1}{2}d\right\}=\sum_{r=1}^{n}\{a+(r-1)d\}$$

(5) $$\frac{a(r^n-1)}{(r-1)}=\sum_{k=0}^{n-1} ar^k,$$

are found in all Hindu mathematical works. The problems of finding out (1) the common difference of an A.P. or the common ratio of a G.P., (2) any desired term, (3) the number of terms, and (4) the insertion of a given number of arithmetic or geometric means are also common to all Hindu works.

The treatment of series found in the works of Mahâvîra (850) and Nârâyaṇa (1350) is more detailed than in others. These writers give formulae for finding the sums of series formed by the squares or cubes of the terms of given arithmetic series. According to Mahâvîra

$$\sum_{r=1}^{n}(a+\overline{r-1}b)^2=n\left[\left\{\frac{2n-1}{6}b^2+ab\right\}\times(n-1)+a^2\right]$$

and according to Nârâyaṇa

$$\sum_{r=1}^{n}(a+\overline{r-1}b)^2=a\sum\{a+2(r-1)b\}+b^2\sum_{r=1}^{n-1}r^2.$$

Both Mahâvîra and Nârâyaṇa state that

$$\sum_{r=1}^{n}(a+\overline{r-1}b)^3=b.S^2+Sa(a\sim b)$$

according as $a>$or$<b$; where $S=\sum\limits_{r=1}^{n}(a+\overline{r-1}\,b)$.

Series of Sums

Let $\quad N_n=1+2+3+\ldots\ldots+n,$

then, the series

$$\sum_{r=1}^{n}N_r,$$

formed by taking successively the sums up to 1, 2, 3, ... terms of the series of natural numbers, is given in all Hindu works, beginning with that of Âryabhaṭa I, who gives the result as

$$\sum_{r=1}^{n}N_r=\frac{n(n+1)(n+2)}{6}$$

$$=\frac{(n+1)^3-(n+1)}{6}$$

Mahâvîra has generalized the above series of sums in the following manner:

Let $\alpha_1+\alpha_2+\alpha_3+\ldots\ldots+\alpha_n,$

be a series in arithmetical progression, whose common difference is β, so that $\alpha_r=\alpha_1+(\overline{r-1}\,\beta)$. He then considers the following series

$$\sum_{r=1}^{r=n}\left(\sum_{m=1}^{m=\alpha_r}m\right)$$

and gives its sum as

$$\frac{n}{2}\left[\left(\frac{(2n-2)\beta^2}{6}+\frac{\beta}{2}+\alpha_1\beta\right)(n-1)+\alpha_1(\alpha_1+1)\right]$$

Nârâyaṇa gives the above result in another form. According to him

$$\sum_{r=1}^{n}\left(\sum_{m=1}^{\alpha_r}m\right)=\left(\sum_{1}^{\alpha_1+\beta}m-\sum_{1}^{\alpha_1}m\right)\sum_{1}^{n-1}m$$

$$+n\sum_{1}^{\alpha_1}m+\beta^2\sum_{1}^{n-2}\left(\sum_{1}^{r}m\right)$$

Narayana's Series

Nârâyaṇa has given formulae for the sums of series whose terms are formed successively by taking the partial sums of another series in the following manner:

Let the symbol ${}^nV_1$ denote the series of natural numbers, *i.e.*, let

$${}^nV_1=\sum_{1}^{n}r.$$

Let ${}^nV_2$ denote the series formed by taking the partial sums of the series ${}^nV_1$. Thus

$$ {}^nV_2 = \sum_{r=1}^{n} {}^rV_1. $$

Similarly, let

$$ {}^nV_3 = \sum_{r=1}^{n} {}^rV_2, $$

$$ {}^nV_m = \sum_{r=1}^{n} {}^rV_{m-1}. $$

Nârâyana states the following formula for the sum of the series ${}^nV_m$:

$$ {}^nV_m = \frac{n(n+1)(n+2)\ldots\ldots(n+m)}{1.\ 2.\ 3.\ \ldots\ldots (m+n)} $$

He has further considered the more general series obtained in the same way as above from an arithmetic series.

Let

$$ {}^nS_1 = \sum_{1}^{n} \alpha_r, $$

an arithmetic series whose first term is α_1 and common difference β. As above let us define the iterated series ${}^nS_2$, ${}^nS_3$, ... ${}^nS_k$ as follows:

$$ {}^nS_2 = \sum_{r=1}^{n} {}^rS_1, $$

$$ {}^nS_k = \sum_{r=1}^{n} {}^rS_{k-1}. $$

According to Nârâyana, the sum of the series ${}^nS_k$ is given by the formula

$$ {}^nS_k = \alpha_1 \frac{k+1}{n-1}\, {}^{(n-1)}V_k + \beta\, {}^{(n-1)}V_k $$

Infinite Series

Talakulatturâ Nambutirî (1432) discovered an infinite series for the arc of a circle in terms of its sine and cosine and the radius of the circle. If r denotes the radius of the circle, α an arc of it and θ the angle subtended at the centre by that arc, then

$$ \alpha = r\,\theta = \frac{r\,\mathrm{Sin}\,\theta}{1.\,\mathrm{Cos}\,\theta} - \frac{r\,\mathrm{Sin}^3\,\theta}{3.\,\mathrm{Cos}^3\,\theta} + \frac{r\,\mathrm{Sin}^5\,\theta}{5.\,\mathrm{Cos}^5\,\theta} - \frac{r\,\mathrm{Sin}^7\,\theta}{7.\,\mathrm{Cos}^7\,\theta} + \ldots\ldots $$

where $0<\theta<\pi/4$, and

$$ r\,\pi/2 - \alpha = \frac{r\,\mathrm{Sin}\,(\pi/2-\theta)}{1.\,\mathrm{Cos}\,(\pi/2-\theta)} - \frac{r\,\mathrm{Sin}^3\,(\pi/2-\theta)}{3.\,\mathrm{Cos}^3\,(\pi/2-\theta)} + \frac{r\,\mathrm{Sin}^5\,(\pi/2-\theta)}{5.\,\mathrm{Cos}^5\,(\pi/2-\theta)} - \ldots $$

where $\pi/4<\theta<\pi/2$.

The above series are given also by Pathumana Somayâjî (1733) and Śankaravarmana (c. 1700). The former gives the well known expansions of the sine and cosine of a given angle in terms of that angle:

$$ \text{Jyâ}\ \alpha = r\,\sin\,\theta = \alpha - \alpha^3/r^2 3! + \alpha^5/r^4 5! $$

which in modern notation can be expressed as

$$ \mathrm{Sin}\ \theta = \theta - \theta^3/3! + \theta^5/5! - $$

and

$$ \text{Kotijyâ}\ \alpha = r\,\mathrm{Cos}\ \theta = r - \alpha^2/r2! + \alpha^4/r^3 4! - \ldots\ldots $$

which can be written as

$$ \mathrm{Cos}\ \theta = 1 - \theta^2/2! + \theta^4/4! - \ldots\ldots $$

Calculus

The Hindu mathematicians made use of the infinitesimal increment, *i.e.*, the differential of given functions under the name *tâtkâlika-gati* (instantaneous-motion). Mañjula (932) gives the differential formula

$$ \delta u = \delta v \pm e\ \mathrm{Cos}\ \theta\ \delta\theta, $$

corresponding to the equation

$$ u = v \pm e\ \mathrm{Sin}\ \theta\ \delta\theta. $$

He uses the result for the determination of the true motion of a planet. He says:

" True motion in *minutes* is equal to the cosine (of the mean anomaly) multiplied by the difference (of the mean anomalies) and divided by the

chheda, added or subtracted contrarily (to the mean motion)"[41].

The differential of sin θ is termed by Bhâskara II as the *tâtkâlika bhogya-khanda*, and the differential formula

$$\delta\ (\sin\theta) = \cos\theta\ \delta\theta$$

has been proved by him. It has been used by him for calculating the *ayana-valana* (angle of position). He has further made use of the following theorems:

(1) When a variable attains its maximum value, its differential vanishes.

(2) When a planet is either in apogee or in perigree, the equation of the centre vanishes, therefore, for some intermediate position the increment of the equation of centre also vanishes.[42]

Another very remarkable formula for the differential of a function involving the inverse sine function as well as the quotient of two functions, one of which is under the radical sign, is the following:

$$\delta\left\{\mathrm{Sin}^{-1}\left(\frac{a\sin\theta}{\sqrt{b^2+2ab\cos\theta+a^2}}\right)\right.$$

$$=\left(\sqrt{b^2+2ab\cos\theta+a^2}-\frac{b(b+a\cos\theta)}{\sqrt{b^2+2ab\cos\theta+a^2}}\right)$$

$$\times\frac{\delta\theta}{\sqrt{b^2+2ab\cos\theta+a^2}}$$

This result occurs in the works of Âryabhata II[43] (950) and Bhâskara II[44] (1150).

Magic Squares[45]

A rule for the construction of 4-magic squares (*i. e.*, magic squares of sixteen cells) is found in a work on magic, known as the *Kakṣshaputa*. One of the squares constructed by this rule is called *Nâgârjunîya*, and is thus attributed to the celebrated alchemist Nâgârjuna, who flourished about the second or the third century after Christ.

The Hindu astronomer Varâhamihira (505) has given a 4-square with total 18, and has called it *sarvatobhadra* (magic in all respects). This square is continuous according to the definition of Paul Carus.

In a Jaina inscription found among the ruins of the ancient town of Khajuraho occurs 4-square with total 34. This belongs to the eleventh century. In the *Tijapapahutta stotra* we find another 4-square with total 170. The date of this is uncertain, but it cannot be later than the fourteenth century.

It is thus clear that the 4-square was the first to attract attention in India. The Chinese are said to have been in possession of a 3-square with total 15 about the beginning of the Christian Era.

A complete theory of the construction of magic squares is found in the *Ganita-kaumudî*, a work on arithmetic and mensuration, by the Hindu mathematician Nârâyana, who flourished in the fourteenth century. It is probably the first work that contains a mathematical exposition of the subject of magic squares. It is here that we find for the first time a classification of magic squares into 4_n, 4_n+2 and $4_n\pm1$ types. Nârâyana gives methods for the construction of 4_n and $4_n\pm1$ squares by the method of superposition of two skeleton squares. This method of superposition was discovered in the west by de la Hire (1705) and forms the basis of most of the work that was subsequently done on the subject. Nârâyana gives also the method of the knight's move for the construction of 4_n-squares as well as the well-known method of constructing odd squares by filling parallel to the diagonal. He attributes these methods to previous authors.

A number of interesting squares constructed by novel methods are found in the writings of the Jain monks Dharmânanda and Sundarasûrî both of whom lived in the fifteenth century. Two of these methods have been discovered recently by Schubert and Andrews respectively.

[41] *Laghumanasa*, *vi*. 7. Here *chheda* (divisor) = 1e.

[42] These results occur in the Goladhyaya Spastadhikara vasana of the *Sidhanta Siromani*, and were first noted by S. Dvivedi.

[43] *Mahasiddhanta*, *iii*. 27.

[44] *Siddhanta Siromani*, Grahaganita, Spastadhikara 39.

[45] See a forthcoming article in the *Scripta Mathematica*, also *Comptes Rendus du Congress International des Mathematiciens*, 1935, pp. 275*f*.

Twenty Years of Soviet Physics

A. F. Joffe

[We reproduce from the "Physikalische Zeitschrift der Sowjet Union" an article by the Academician A. F. Joffé, entitled "Twenty Years of Soviet Physics." The article will prove interesting to our readers in view of the parallelism which exists between Soviet Physics and Indian Physics. Many of the remarks made by Joffé with respect to the cultivation of physics in pre-War Russia may apply word for word to Indian conditions before the War.

But there the parallelism ends. The new life in Soviet Physics is entirely due to patronage of the State, as is evident from Joffé's article. As has been described in the forthcoming volume on "Twentyfive Years of Progress of Physics in India" (written for the Silver Jubilee Session of the Indian Science Congress), Indian physicists have made great contributions to physics within the last twentyfive years,—a fact which is recognized by scientists all over the world. But the Indian Government is not entitled to any credit for the growth of the physical science in India. Credit is due mostly to private donors to Sir T. N. Palit and Sir R. B. Ghose, whose princely donations enabled the Calcutta University to start the University College of Science; to the late Dr Mahendralal Sircar who started the Indian Association for the Cultivation of Science nearly 60 years ago, to the Tatas who started the Indian Institute of Science, to the Maharajah of Jeypore whose munificent donations enabled the Andhra University to start their College of Science, and to the other numerous donors whose munificence was responsible for the establishment of universities at Benares, Aligarh and some other places. As far as we are aware, the only grants which the Government of India makes towards research in physics are a research grant of Rs 18,000/- towards the Indian Association for the Cultivation of Science and a grant of Rs 50,000/- towards the Bose Research Institute. Considering the size of India, and growing demand of physicists, these grants are extremely trivial. The conditions in India were analysed by Prof. M. N. Saha in his Presidential Address to the annual meeting of the Indian Physical Society held at Hyderabad in January, 1937, from which the following passages are taken: Prof. Saha begins with a quotation from Dr K. T. Compton, President of tht Massachusetts Institute of Technology.

" 'Historically we note that the Science of Physics has given birth nearly to all those ideas, processes and agencies which have brought man to an understanding of the Material Universe, and to the use of its forces, Civil Engineering, a large part of Chemical Engineering, Metallurgy, Electrical Communication, Refrigeration, Testing, Ventilating, Automotive, and Aeronautical and the countless products of those arts which have revolutionized modern life, not only in its material aspects, but also in intellectual, economic and social relationships. Physics has not only originated these things, but continues to develop them.'

" As a matter of fact a science which is playing such a great part in the evolution of human civilization has certainly a great claim on Society and Government. The material prosperity and political safety of countries are intimately connected with the active cultivation of our Science.

' It is, therefore, natural that in Europe, America, and Japan, increasing attention should be paid to the teaching of our subject in elementary and advanced schools, in professional schools, in the universities and technical high schools, in special research institutions maintained by the Government, private benefactions, or by the great industries which have sprung up as a result of the discoveries made in physics. Large amounts are willingly spent on research by Governments and Research Foundations. In England, the country which we follow, the change in the official attitude and the attitude of industrialists towards

research since the Great War has been remarkable. Sir J. J. Thomson records in his personal recollections that in his days he had great difficulty in getting money for a little extension to the overcrowded Cavendish Laboratory and he had to do it by accumulating little savings for a number of years from the recurring laboratory grant...But largely as a result of the lessons learnt during the Great War, the attitude has been completely changed. Not only are the University laboratories far better equipped, but the number of research fellowships has increased enormously. You have all heard of the magnificent gift of Sir H. Austin to the Cavendish Laboratory, and of Lord Nuffield to the Oxford University, part of which will be spent on the improvement of the Clarendon Laboratory. Further, the Department of Industrial and Scientific Research spends about 1.30 million pounds in giving small doles to research workers, and a large number of them are workers in physics. The Royal Society of London has been getting endowments for founding research professorships, and only a week ago, they were recipients of a magnificent sum of two million pounds. It is calculated by J. Huxley that the Industries in England spend about 5 to 6 million pounds in scientific research, and in the United States of America about 300 million dollars are annually spent in scientific research by Industries alone. A large part of this sum naturally goes to researches in pure physics or to researches in associated subjects. As a result of these endowments I found very few students of physics unemployed; for the intellectually-minded it is quite easy to get research fellowships which enable them to keep the wolf out of doors while they are struggling with a fundamental problem. For those who have a mechanical and commercial bent of mind, there are hundreds of industrial concerns willing to profit by modern discoveries. What a sad contrast to the medieval conditions prevailing in this country!"

— *Ed., Sc. & Cul.*]

PRE-REVOLUTIONARY Russia could be proud of a number of scientists who have left a mark in the history of physics. Besides D. I. Mendeleyev,[1] who was not only an outstanding chemist but a remarkable physicist as well, we may cite the names of P. N. Lebedev[2], Stoletov[3], and B. B. Golitsin[4]. These three names are associated with important advances in physics, such as the pressure of light, the photo-effect and seismology. But usually the pre-Revolutionary Russian scientists were isolated workers who did not leave behind them a scientific school or a definite trend in science. Their own subjects of research were, for the most part, borrowed from abroad as a result of work under some French or German scientist. After he had worked for some time in a western school and carried out an investigation falling in the general trend of work of this school, the Russian scientist would turn it into a dissertation for an M.A. degree. The further development of this theme would take the form of a dissertation for the doctor's degree, while the foreign centre of the idea continued to exert its influence upon him. No independent Russian school came into being.

The only exception was the remarkable scientific school of P. N. Lebedev at the Moscow University. But in 1911 the policy of the Tzarist Government drove it out of the University and shortly after this P. N. Lebedev died. One part of this school, centered around P. P. Lazarev, passed to the Institute of Biophysics primarily destined for Lebedev. The other part returned to the Moscow University much later.

Matters stood considerably worse in Leningrad before the Revolution. The University was sterile. The absence of keen, creative thought and the disheartening system of examinations for the degree repelled the most gifted of physicists (Gershun, Mitkevich, Lebedinski). The scientific schools which developed

[1]Mendeleyev—Author of the Periodic Classification.

[2]Lebedev Lebedev (1903) was the first to demonstrate experimentally the existence of the Pressure of Light, which was first suspected in the Middle Ages by Kepler, but was first predicted by Maxwell on experimental grounds about 1870.

[3]Stoletov—Stoletov carried out important researches on photo electric effect.

[4]Prince Golitsin, along with Milne, Omori (Japan) Weichert (Germany), was one of the pioneers in the study of earthquakes. His 'Electromagnetic Seismograph' is still widely used.

in Leningrad after the Revolution are offsprings not of the University but of foreign laboratories of Paris (Rojdestvenski), Munich (Joffé) and Göttingen (Rojanski). Just before the Revolution at the Leningrad Polytechnic Institute a school of physicists had formed, which afterwards became the nucleus of the Physico-technical Institute. Great influence over the young physicists of the last pre-Revolutionary years was exerted by P. S. Ehrenfest,[5] who took the chair of theoretical Physics in Holland when he became aware of the impossibility of continuing his work in Russia. He became one of the best friends of the Soviet Union.

Before the Revolution the development of physics was confined almost exclusively to universities and one or two technical colleges. The number of doctors of physics did not exceed 15. The total number of physicists engaged in scientific work was about 100, but for the overwhelming majority it was a collateral work along with their regular occupation, which was teaching. Outside the universities and technical colleges and except for the small laboratory of the Academy of Sciences, devoted to seismology, physicists were employed at the Central Board of Weights and Measures, of which the physicist N. G. Yegorov was appointed director after Mendeleyev, and at the Central Physical Observatory. But the domain of their work (seismology, measurements, meteorology) was but partially related to the fundamental problems of physical research.

Some of the works of Lebedev's school and of several Leningrad physicists had considerable scientific interest. But the major part of the scientific production did not claim to enrich world science. It was distinctly provincial, descriptions of observations without theoretical interpretation, variants of foreign work, measurements of some constants or other, etc. The " scientific work " of the research students of the Leningrad University consisted in reproducing the experiments published in the last issue of a foreign reveiw.

But even the best works of the Russian physicists were disconnected investigations, which did not constitute a definite scientific line of research nor did they propose any more profound physical or technical problems. It may be asserted that in pre-Revolutionary Russia technical physics was well-nigh absent and there were no conditions for its coming into being. Imported from abroad ready-made, including even the working-drawings, Russian engineering never had nor needed a scientific basis of its own. The university physics deemed degrading every contact with practice. The universities guarded jealously the " purity " of science and kept it away from engineering.

Thus, in spite of the existence of several great scientists, Russian physics before the Revolution was one of the weakest and most backward detachments of world science.

Physics was one of the first to feel the vivifying influence of the Proletarian Revolution. As early as 1918 the principal physical institutes were created in Leningrad, *viz.*, the Physico-technical and the Optical Institute, which rallied all the living forces of the Leningrad physicists.

In 1919 the physico-technical faculty of the Polytechnical Institute was formed, which later gave the leading cadres of the physico-technical institutes and several factory laboratories. The Soviet physical institutes rejected from the outset the fetish of pure science and bound up their work with the problems of technical progress. In 1920 they organized a physical association, which put forward the task of creating scientific centres in different republics and provinces of the Union and was the first to attempt to bring elements of planning into scientific work. In 1923 was organized the Physico-technical laboratory of the Supreme Economic Council which later split up into the Institute of Electrophysics, Technical Heat, Chemical Physics, Physico chemical problems, Telemechanics, Television, Musical Acoustics and the Laboratory of electrotechnical materials. At the moment of becoming independent institutes each of them already possessed a trained staff and equipment, its own field of

[5] P. S. Ehrenfest. Theoretical Physicist who till 1934 was Professor of theoretical physics at Leiden in Holland. He, along with his wife, T. Ehrenfest, who was Professor of Physics at Moscow, is the author of the Theory of Adiabatic Invariants.

work and well elaborated methods of research. The Radium Institute issued from the Physico-technical Institute.

During the same time the Optical Institute expanded and widened its scope, which included, besides physical optics, the manufacture of optical glass, the manufacturing of optical instruments, photography, lighting technique and the treating of surfaces.

Moreover, there were founded in Leningrad the Central Radio Laboratory and the Institute of wire communications, the Board of Weights and Measures was reconstructed into the Institute of Meteorology and the Physical Observatory into the Institute of Geophysics.

Thus, besides the physical laboratories of the universities and technical colleges (which have greatly increased in number and extent) and some special laboratories, five big physical institutes and ten institutes of applied physics have been created in Leningrad during the twenty years since the Great Proletarian Revolution.

In Moscow the development took another course. Physics continued to be grouped around the two centres, the Institute of Biophysics and the Physical Institute of the University. Later physicists and groups of physicists began to enter the Industrial Institutes, of Electrotechnics, Applied Heat, Applied Mineralogy etc. After the Academy of Sciences had been transferred to Moscow, the Physical Institute of the Academy began to develop, which concentrated the best workers of the University, some of the former collaborators of the Institute of Biophysics and several Leningrad physicists.

Beginning from 1929 new physical centres arose in the most important republics and provinces of the Union. Their leading cadres were supplied by the Leningrad Physico-technical Institute. Thus were created the physico-technical institutes at Kharkov, Tomsk, Dnepropetrovsk, Sverdlovsk. Each of them is an all-Union scientific centre in its own field: in low temperatures and high tensions (Kharkov), physics of metals (Sverdlovsk), X-ray analysis of metals (Dnepropetrovsk). The new field of the atomic nucleus is dealt with chiefly by the Leningrad and Kharkov institutes, but also by the Radium Institute and the Physical Institute of the Academy of Sciences.

The other physical institutes founded during these twenty years are the Physical Institute of the Ukrainian Academy of Sciences at Kiev, the Physico-technical Institute at Gorky and the Physical Institute of the Odessa University. The rise of new scientific centres in the republics and provinces of the Union is still going on.

The number of physicists have increased tenfold in these years. More than 1,000 physicists not only participate in scientific work but regard it as their basic occupation. Nearly all of them belong to the younger generation, whose active life began in the Soviet Union. Of the physicists who have worked before the Revolution not more than 20 are still engaged in creative scientific work. Some institutes consist entirely of physicists of the post-Revolutionary period (Kharkov, Sverdlovsk, Dnepropetrovsk).

By the year 1930 the products of Soviet physicists which were till then published in foreign journals increased to such an extent as to fill 25 to 30% of the fundamental German review, the *Zeitschrift für Physik*. Then the Soviet physicists started two journals in foreign languages, the *Physikalische Zeitschrift der Sowjetunion* at Kharkov and *Technical Physics of the USSR* at Leningrad. These reviews concentrated more than 90% of the work carried on in the USSR and won recognition abroad: in 1914-1935 the Kharkov journal was already among the most widely read physical journals. During the last years the reports of the Academy of Sciences have become widespread, and the *Transactions* of the physical group of the Academy of Sciences have been constituted afresh.

Soviet physics markedly differs from pre-Revolutionary physics not only as to the number of works and workers but also in quality. The provincial subjects and methods are things of the past. In not less than twenty problems of the greatest importance treated by world physics the Soviet science holds a prominent, sometimes even a predominant position.

Special notice must be taken of the development of the numerous branches of applied physics, which did not exist at all before the Revolution. The *Journal of Technical Physics* is twice as large as the *Journal of General Physics*.

In place of the loose unconnected questions which were treated before the Revolution, we see a wide scope of physical research. However, there are still blank spots in this field, particularly in the domain of applied physics where the gaps fall on the most responsible sections, oil and coal, metallurgy, textile and paper industry, mining and hydraulics.

During the past 20 years Soviet physics has sometimes played a leading part in certain directions. Thus it was in 1923-1930 with the electric properties, in 1924-1928 with plasticity and strength questions, in 1930-1934 with Segnette-Electricity, in 1925-1933 with anomalous dispersion, in 1928-1935 with the kinetics of chain reactions, and since 1930 with non-linear oscillations. One of the most outstanding discoveries of this period, the Raman-effect, was observed in the USSR by Mandelstam and Landsberg several months before Raman.*

In a number of articles a survey will be given of the most important results achieved by Soviet physics in the course of these twenty years. The following branches of technical physics created in the USSR within this period may be named.

1. Optical technique, calculation and design of optical instruments.
2. Lighting technique, calculation of lighting.
3. The photographical process.
4. Spectral analysis in geology and metallurgy.
5. X-ray analysis of metals and alloys.
6. Electrical insulation.
7. Production of optical glass.
8. Electrical prospecting and seismology.
9. Crystalline structure of metals and alloys in connection with thermal treatment.
10. Television and telemechanics.
11. Application of low temperatures to the separation of gases.
12. Radio technique and vacuum technique.
13. Solid and gaseous current rectifiers.
14. Solid and vacuum photocells.
15. High-tension technique.
16. Agrophysics.
17. Heat engineering.
18. Musical acoustics.
19. Surface treatment.
20. Chemical industries.

However, the technical physics created after the Revolution has not yet attained a sufficient development and cannot fulfil the requirements of the rapidly growing industry.

Soviet physics has thoroughly outstripped the scientific front and has lost its provincial character. In some fields (non-linear oscillations, chain reactions) Soviet science plays a leading role. In many other domains the Soviet scientists are in the front ranks of modern physics. There are also original branches of technical physics (chemical polishing, agrophysics) created in the USSR. Of the discoveries which have revolutionized science, the splitting of the atomic nucleus, wave-mechanics, the discovery of the neutron and the positron, the diffraction of electrons and electronic optics, the Raman effect, the last was simultaneously discovered in the USSR.

Summing up the present state of Soviet physics we must acknowledge, in spite of its achievements, that it falls behind our industry, which in a number of branches has already occupied the first places.

The glorious task now set before physics is to overtake our rapidly growing industry and, together with industry, to surpass the other advanced countries. The exceptionally favourable conditions of our socialist country ensure the practical possibility of great scientific achievements and the profound penetration of science into life.

*The consensus of the world-opinion is however in favour of C. V. Raman as the prior discoverer. Academician Joffé may be excused for his patriotic feeling in claiming the discovery for his own countrymen. However in another place, Joffé accords the priority to Raman.

Our Museums—A Plea for an Ethnographic Section

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There are in India today 105 museums, no less than 37 of which are directly administered and financed by the Government of India or by Provincial Governments. Most of these museums devote themselves entirely to archaeological and historical collections. There are a few, however, which exhibit ethnographical, zoological or geological specimens, but there is little doubt that in India there is a systematic bias in favour of archaeological materials.

The functions of museums are usually collection, preservation and chemical treatment of suitable exhibits, their arrangement and interpretation and also provision for educational facilities and research. Students of history, archaeology and anthropology have long realized the important role of museums in their curricula. Any course in pre-historic archaeology, ethnography and technology must necessarily be based on a first-hand knowledge of specimens in museums. Yet museums in India play a limited role for the following reasons, *viz.*, (1) the phenomenal illiteracy of the masses, (2) the nature of museum collections, which appeal only to a particular section of the intelligentsia, (3) inefficient handling of the specimens, (4) absence of any arrangement in the museums to explain and interpret the collections to laymen, and lastly (5) a certain show of officialdom in our museums. The museum experts sent by the Carnegie Corporation of New York, who toured India to inspect Indian museums, recently emphasized in their report the need of appointing efficient curators and made several other important recommendations.[1] But unless we tackle the whole question of museum administration and evolve a museum policy for the country, no piecemeal arrangement will solve the problem of museum organization and control.

In a recent lecture before the Royal Society of Arts (see *Nature*, Dec., 25, p. 1108, and also of Jan., 29, 1938, p. 177) Mr J. de La Valette explained how far museums of Holland are promoting the study of the native cultures of the Dutch possessions in Indonesia, and how they aim to make familiar to the Dutch people the conditions of native life in these remote parts of the world, for the administration of which they themselves are finally responsible. The need of an ethnographical museum for the British Isles has long been felt and many distinguished scholars and administrators have urged the establishment of an Imperial Bureau of Anthropology or an Imperial Ethnographical Museum as the best means of promoting an educated interest among the general public in the cultures of the peoples inhabiting the dominions and colonies. In an editorial note on the subject of ethnographical museums, *Nature* publishes the following:[2]

> "On the grounds of public policy, the formation of a Museum of Indian life and culture cannot be too strongly urged. Now that the bonds of Empire have become tenuous indeed, we hold India by a thread. But impalpable bonds, as has been shown by the visit of the British Association delegation to the Jubilee Meeting of the Indian Science Congress Association this month, can be made stronger than any material force. To the degree in which our future policy towards India is rooted in an understanding of Indian aspirations on the part of the British people, the greater the strength of the bonds that will hold this great country within the Empire. A great Indian Cultural Museum would certainly contribute the major part to such an understanding. It would show that, whatever the differences between the two peoples may be, to India belongs a civilization older than our own, which in art and intellectual accomplishment has been in no way our inferior, while in Buddhism it has produced a creed which more nearly than any other in the world's history approaches the way of life inculcated by Christianity."

[1] Report of the Museum Committee appointed by the Carnegie Corporation of New York, 1937.

[2] *Nature*, January 29, 1938, pp. 177-79.

If the formation of a Museum of Indian life and culture is so desirable for England, its importance to Indian life and culture cannot be exaggerated. At no part of India's chequered history has there been a greater need to understand the cultures of the innumerable tribes and castes that constitute the nascent Indian nation. Yet there is hardly any attempt made by the authorities concerned to popularize knowledge of the different levels of culture existing in India. In other countries the value of a representative collection has been fully recognized, but in proportion as the value is being appreciated at its true worth, the material for ethnographical study is diminishing. In many cases native beliefs and institutions have already become obsolete. In India where data about primitive life are still abundant, no systematic efforts have been made to collect and exhibit even the material aspects of primitive life. Technological specimens of Indian tribes and castes have been taken to all parts of the world and have formed important collections in foreign museums. The India Museum in South Kensington, London, exhibits the industrial arts of India and the ethnography of the primitive tribes of India is suitably displayed in the British Museum. But seldom do we find any important museum in India doing this except two or three that possess a heterogeneous collection, devoting one square foot of the floor area to the display of such stuff.

Human handicraft through the ages has formed an important source of inventions in all parts of the world and it is rarely that we find any attempt in our museums to demonstrate the stages which the different tools and machines have passed through. The War Museum in Germany is doing for the Germans what a dozen military schools may fail to achieve. The Art Galleries in Berlin, Vienna and Paris have inspired thousands of artists. The ethnographic section of the Deutsches Museum has determined the activities of hundreds of explorers and colonists. Many of the specimens in the ethnographical collections of the British Museum are connected with British enterprise and exploration. The voyages of Cook, Vancouver and others including the explorers who took part in the search for Franklin are represented in the Museum and the magnificent collection of the London Missionary Society now shown in the Pacific Section illustrates another phase of British enterprise among unknown and little known peoples, which every man in the British Isles takes legitimate pride in.[3]

India is said to be an epitome of the world, and so it is. We have in India hundreds of different racial and cultural groups. We differ in language, race, culture and in our food, habits and temperament, but we have not cared to acquaint our people with these facts of vital importance. Most of our political troubles within the country are traceable to ignorance, ignorance of the communities about their respective cultures. A knowledge of the culture patterns of the important communities will certainly help to develop a spirit of toleration and goodwill which will minimize the communal tension and may even eradicate the virus from the body politic. And this is possible through a study not only of the material aspects of life, but also of the social institutions of the people. Human life is made up of parts, just like the parts of an interlocked machinery. Each part is of no use by itself; it can do nothing except to assist the whole to function. The whole again is not merely the sum of all its parts but the result of a unique arrangement and interrelation of the parts that has brought about a new entity. The best way to see life is to see it as a whole. The different aspects of life of the people, therefore, should be studied together with their interrelation. In his lecture before the Royal Society of Arts, already referred to, Mr Valette pointed out how in their method of approach to the problem of the arrangement and organization of an ethnographical museum demonstrating the mode of life of their dependencies, the Dutch are in harmony with the modern tendency towards a humanism in anthropological studies, in which the various disciplines of the study of man, ethnology, physical anthropology, archaeology, history and the like, set apart for academic purposes in the past, are once brought together and focussed on the study of a single integrated group of culture. Man, his works and his environment are thus studied as a single and

[3] *Handbook to the Ethnographical Collections, British Museum, p. vi.*

unified whole and not in water-tight compartments.[4]

The study of the material and non-material aspects of the cultures of the different racial and cultural groups in India will equip the Indian student with a knowledge of the primary and fundamental facts of life, and, as such, will provide a broader basis for mutual understanding and adjustment without which a healthy development of the political institutions will be difficult to achieve. It is, therefore, necessary in the interests of social harmony and communal concord to equip our museums with an ethnographic section which will be readily accessible to the students of universities and colleges so that they may acquire the necessary information about the people of the country and their habits, customs, and institutions.

The researches of a great many scientists, which have enriched our knowledge of human life and institutions, were begun in the museums of their respective countries. Sir E. B. Tylor examined the material in the collections of Pitt-Rivers and others, and developed his famous thesis on the origin of fire-making in which he showed that man first kindled fire by simple wood-friction, passed through several successive steps in elaborating the fire drill, and later discovered the use of flint and iron pyrites, finally ending with the friction match.[5] This and many similar investigations could be undertaken from a study of museum collections.

Museums, as we all know, started from the cabinets of curio hunters. Man has a weakness for curios, and explorers, travellers and missionaries began to collect curious objects from strange lands. The discovery of new lands made it possible to collect objects made by savage and semi-savage peoples. The scientific value of these objects was realized as late as the middle of the nineteenth century. Pitt Rivers, one of the pioneers of the museum movement, entered upon the collection and study of the objects made by living man on the theory that their genesis or development would be read in the objects themselves, just as structure in the bodies of animals and plants is taken as the evidence for their evolution.[6] If the story could be read in the objects themselves, then it was apparent that the study of the objects was an important line of investigation for the solution of the vexed problems of origin and development of specimens of human handicraft and their spread and diffusion.

Next to Pitt-Rivers, O. T. Mason did a lot for the development of modern museums. Mason was very much interested in the geographical distribution of material objects of human handicraft. He arranged his specimens in a tribal and geographical setting and through the arrangement sought to discover from his collections the origin of technological processes. His exhaustive work on basketry, based on the collections in the United States National Museum at Washington, remains a classic even to this day.[7]

Very few of the Indian museums possess adequate material for such investigations and those that possess a nucleus are not organized on scientific lines. Museums are important; they are not curio-shops; they have an important role to fulfil in the national life of the country, and the sooner we realize this the better it is for our country. Museums are not 'Jadughars.' They should provide facilities for students of culture to pursue their lines of investigation. Museums are research institutions and should not be reduced to mere purchasers of the curios offered to them by unscientific collectors. We need a museum policy for our country. We need substantial grants from the provincial exchequers towards their maintenance and expansion, and we need "men of acknowledged integrity and learning, who possess an enthusiasm for museums and are prepared to give time to understanding modern museum practice".[8] Above all, we need [illegible]ed hands who can make the collections tell their tale. Unless we have all these, museums are not expected to play any significant role in the education of the people for whom they should primarily exist.

Now that we have popular Government in most of the Provinces, may we not hope to get a lead from the Government of the day?

[4] *Nature*, January 29, 1938, pp. 177-79.

[5] Clark Wissler—*Introduction to Social Anthropology*, pp. 286-289.

[6] *Ibid.* [7] Mason—*Origin of Inventions.*

[8] Report of the Museum Committee appointed by the Carnegie Corporation of New York, 1937.

Symposium on India's Power Supply

At the Annual Meeting of the National Academy of Sciences, India, held on March 5, 1938, a symposium was arranged on the subject of India's Power Supply. Among the participants in the discussion were Professor Meghnad Saha (Allahabad University), Prof. B. C. Chatterji and Prof. N. N. Godbole (Benares Hindu University), Prof. N. G. Chatterji (Cawnpore), Prof. B. P. Adarkar, Dr G. R. Toshniwal and Dr A. N. Tandon (Allahabad University). There was a select gathering of scientists and others. Pandit Jawaharlal Nehru presided.

In opening the discussion, Prof. M. N. Saha said that one of the objects of the National Academy of Sciences was to organize discussions on subjects of great national importance. He continued: No subject could, at the present moment, be of greater importance than that of cheap and abundant power supply, for the whole industrial efficiency of a nation depends upon it. In former times, man depended entirely upon his own muscles for work, or upon that of his slaves or animals like horses, bullocks, asses and elephants. Forces of nature like those of wind, running water, etc., were also used, but in a very inefficient way during ancient and mediaeval times. But the whole aspect changed with the discovery of the steam engine, with the use of electricity, and with the discovery of oil engines in the last century.

There are countries in the world, which have completely harnessed all their power resources, *e.g.*, Norway, U.S.A., England and Germany. There are others who are half way towards it—*e.g.*, Russia. There are others who are still dependent on a mediaeval economy, *e.g.*, India, China, Abyssinia.

The efficiency of a nation according to modern standards can be measured mathematically. In an advanced country like Norway, the total output of work per head is nearly 1,800 units mostly derived from the harnessing of her rivers and falls. In countries like England and Germany, the power for work is derived from coal, but the output everywhere *per capita* is probably pretty nearly the same. One can contrast with it the output of work per head in India. It cannot exceed 90 units, of which about 60 is from human labour, 10 from animal power, and 20 from steam and electrical power combined. This explains why India is poor, for her output of work per head is twenty times less than that of an advanced country. If India is to solve her problems of poverty and unemployment, she must organize her power resources on a cheap and efficient basis, and bring it to the level of Europe, America and Japan.

The nearest example to India in industrial inefficiency is found in that of China which is now paying the penalty of her lack of organization. Another country was pre-War Russia, which, like India, was a country of peasants (70%), and villages. Her output of work *per capita* in 1912 was almost the same as that of present-day India. Yet by means of a Herculean effort during the last fifteen years, Russia has organized her power resources so thoroughly that she can now show about 500-600 units of electrical energy alone per head. This has enabled her to be transformed from a country of half-starved peasants living in miserable hovels to one of the most efficient industrial nations of present times. Russia, having started late, achieved within fifteen years what other nations took more than half a century to accomplish.

But has the course been smooth in other countries based on a capitalistic economy? No. Even in England and Germany and U. S. A., countries which were pioneers in the development of the technique for power, long conflicts had to be waged between the people and the capitalists, before a smooth course was found. Without going into details of this conflict, the main results may be given. In every country, it has been recognized

that the power resources, namely coal, running water, petrol, and other forms of fuel like power alcohol, wood, peat, and shale, should be regarded as national assets. Stringent rules are framed for the conservation, development, and proper working of these resources. It is further recognized that development of cheap and abundant power is a prime duty of the State, and power, like water or air, should not be allowed to become a commodity for profit, or exploitation by any particular group. The machinery which has been set up to secure this end is rather complicated, but if details are avoided, it can be described in simple terms.

(1) There must be a Power Supply Department whose duty would be to make a systematic survey of the available sources of power,—coal, petrol, running water, etc.—existing within the bounds of the State. It must devise ways and means for their development on economically sound lines;

(2) The State should frame beneficent legislation which will encourage a cheap and abundant supply, and prevent the public from being exploited by capitalists;

(3) The State must train up a batch of indigenous technicians who can plan and carry out schemes of technical construction, maintenance and improvement. No State can depend for such work upon technicians imported from foreign countries.

It is estimated that taking India as a whole, only 2 per cent of her hydro-electric power has been developed. How has Japan developed over 80%? No other figures serve as better index of our backwardness and of the inefficiency of the State. If the available resources are adequately developed, the Indian output of energy can easily approach that of Japan, and India can easily approach Japan in industrial efficiency.

At present, the conditions of power supply in India are almost the same as they were in England nearly quarter of a century ago. In fact, the Indian Electricity Act of 1910 has not been modified on any essential point, while in England, *revolutionary changes in electricity laws were introduced* as a result of the report of the Weir Committee in 1927 and other committees.

According to the present Act, private companies are granted licence for generation and supply of electricity; there is hardly any safeguard against exploitation. Thus, though, now owing to technical efficiency of new machinery, one ton of coal produces nearly four times as much electricity as it used to do 25 years ago, and transmission losses have been reduced to a minimum, the rates have not undergone corresponding reduction. An example may be quoted:—the Calcutta Electric Supply Co., of which Lord Meston is the Chairman, produces electricity at a cost of .35 anna according to the *Electrical Times*. They charge 2 annas per unit for domestic purposes. The charges are nearly 6 times higher than the cost of production. An analysis of the figures for the English supply companies shows that nowhere is the ratio more than 2 or 3. The heroic fight put up by the Calcutta Corporation against the exploitation by the Calcutta Electric Supply Corporation has been rendered abortive owing to the reactionary attitude of the Bengal Government.

The Government's Failures

Like many other States, the Indian Provincial Governments have sometimes ventured on State enterprise for electrification. We may cite, as the best known example, the Mundi Scheme in the Punjab and the Western Ganges Hydro-electric Scheme in the U. P. But the results obtained so far have been rather discouraging. The Mundi Scheme in the Punjab, which was launched under Government initiative against the almost unanimous opposition of the people's representatives, cost nearly Rs 3,000/- per kilowatt installed: this holds the world's record for dearness, and is about 10 times dearer than the average cost of installation of plants of this size in Europe and America. The western Ganges Hydro-electric Scheme which appears to have caught the imagination of a large majority of our countrymen cost Rs 1,200/- per kilowatt installed. This holds the second highest record for dearness, and yet such a project has

been hailed as a great work by a section of our countrymen.

In the Mundi Scheme, nearly 6 crores of rupees were wasted before it was discovered that the river from which power was to be tapped almost ran dry during the hot season.

If a small part of this money was spent on adequate surveys, and preliminary laboratory researches, probably the Government would have received a handsome return on their investment, most part of which has now to be written off as unproductive.

An analysis of the causes of failure of these undertakings shows that

(1) they were undertaken without a proper survey of the existing sources of hydro-electric power;

(2) the electricity developed has not been distributed according to sound economic principles;

(3) the undertakings were mostly in charge of officials who were amateurs in the science of electricity and no steps were taken to train a band of indigenous technicians for the work, and its continuation.

Prof. N. N. Godbole speaking on "Electric Power Supply in Japan" said:—

The enormous progress of Japanese electricity industry can be seen from the following figures. The total number of towns, cities and villages is 11,600 and of these a little less than 11,350 (*i.e.*, more than 97.9%) are electrified. These are hamlets far out of the way and some in far-away islands. Out of the 12,500,000 residential houses and industrial buildings of Japan, at the end of 1933, 11,400,000 households were electrified. This makes a percentage of 91%. Even in America, with the largest of electric power production in the world nearly 25% households are without electric lights. The Japanese houses being made of wood and the congestion being great the electric connections and fittings are easy to make, more so because copper wires and insulators are entirely home-made and are very cheap. The number of electric bulbs in use at the end of 1934 amounted to 4 crores *i.e.*, 59 bulbs for every 100 of the population. The number of miles of railways worked with electricity were only 70 in the year 1903 whereas in 1931, they were more than, 3,700 miles. The mileage under electric tramways in 1934 exceeded 1,600 miles. The municipalities in many cases make it compulsory for every house to fix up and pay for one bulb outside the house which serves as a street lamp and the charge per month for this one bulb ranges between sens 50 to 60 (*i.e.*, in Indian money between As. 7 to 8).

The total hydro-electric reserves of Japan have got a capacity of 14,500,000 H.P. annually of which today only 5,400,000 H.P. are already harnessed. In the year 1933, the total consumption amounted to 18 billion (18,000,000,000) K.W.H. of which 4 billion K.W.H. (23%) were used for electric lighting and 11 billion K.W.H. (67%) were used for motive power. Nearly 90% of this today comes from hydro-electric power and the rest from coal, the latter being used to make up the deficiency of the hydro electric power in winter, when the flow of water falls short of the need for supply. In 1934, the total authorized capital invested in the electricity industry amounted to Y. 4,910,000,000 and the paid up capital was Y. 3,956,000,000.

Japan began by using coal as a source for the power for lighting purposes in 1885 and the first hydro-electric scheme was taken up at Lake Biwa —near Kyoto in 1892. Today the industry has grown enormously and the whole power is centred in a group of five big companies—known as the "Big Five." In all, there are about 818 enterprises controlling small and large plants amounting to 7,115 and of these 114 are municipalities in urban and rural districts producing power for lighting homes and running their own tramways. Nearly 90% of the factories and home-industries use electricity for driving the machines. The *per capita* consumption of Japan amounted to 310 K.W.H. in 1934 and it has gone up since then. In 1933, out of the total income of Y. 921,000,000, Y. 277,000,000 was realized by supplying power for lights. The electro-chemical industries and other heavy industries generate their own power. The cost ranges from 0.6 sen (1 pie) per

unit for larger factories to 6 sens (3 pice) per unit for domestic lighting in Tokyo.

The "Big Five" are controlled by a special Minister, who was appointed in 1932, and in 1937 new legislation was being introduced by the Hirota cabinet, which aimed at a complete State control over the nation's power supply. In December last, a reduction of about 5 sens per bulb was made for the street lights.

Professor B. C. Chatterji, Vice-Principal, Engineering College, Benares, speaking on "The Existing methods of Electric Supply in India" said:—Electricity with the progress of science has been a primary commodity, and as such it must be available to the poorest of our countrymen at the most distant corners of our villages. It must be consistent with economy and safety which has been both neglected and which can be done only when it is nationalized or brought under State control. The reason being that the monopoly—although not allowed by law—but maintained by procedure is in the hands of a few foreign companies whose interests are strongly safeguarded against the welfare of the country in spite of the provisions of the Electricity Act Part II Section 3, page 166 (Meares) which lays down:—

"The grant of license under this part for any purpose shall not in any way hinder or restrict the grant of a license to another person within the same area of supply for a like purpose.

Still the Hon'ble Mr. Blunt said "No" in reply to the following question in the U. P. Legislative Council:

Is the Government prepared to give license also to other companies wishing to supply electric light and power at Benares at a much lower rate than the present one and use lower and safer voltage?."

The problems of electrical power supply may be mainly divided into three parts and are considered accordingly.

Generation including types of Prime Movers and the kind of fuel: the system of supply, *i.e.*, Direct Current or Alternating Current. This further involves the question of frequency, voltage, and the cost of production. Coal is almost the universal fuel in most parts of the world as also in our country. The main difficulty has been the question of transport—a ton of coal at the pit head may cost rupees three or less, but the cost of transport, say at Benares, increases it to rupees fourteen. The railway freight is itself Rs 6/2/- and often the wagons are restricted. The railway freight must be reduced if the industry of our country is to develop and the electrical undertaking to be run on economical lines. The next important source of energy is rain water or "white coal."

With the progress of our country attention has been drawn to the waste of power of the vast quantity of rain water or of the running water of the rivers flowing throughout the country. The energy obtained from these sources is flawless, no smoke nuisance, no confinement in the depths of the mines. In the Western Ghats the rain water is stored up in reservoirs and the biggest hydro-electric schemes are developed—man-made—but at Naini Tal the lake supplies the water and is made by nature. At Shivasamudram nature has been helped by man and a fall has been developed (by the Krishna Raja Sagar Dam). But our resources of waterpower have yet been very little tapped. At the same time the simple method of capitalizing the waste energy of streams is not necessarily identical with the development of waterpower. The hazards involved in both the construction of such properties and in the contingencies of operation and maintenance are considerable. There must be a market in which the power may be utilized with advantage and the price at which it can be sold in competition with other sources of power. This ideal has not been realized in the Ganges Hydro-electric Scheme which produces a unit for 0.87 anna and at the expense of enormous public money. The hydel is further being supplemented by a steam plant at Chandousi of about 9000 K.W. besides other additional plants elsewhere, whereas the Kashmir scheme which is a very small undertaking costs 2.5 pies per unit and even steam plants as at Cawnpore cost 0.35 anna to 0.45 anna a unit. If the hydro-electric schemes are fully developed in all the provinces within reasonable cost and the steam stations in the coal area are carefully undertaken they may be inter-linked and it will be quite possible to take electricity at the door of the poorest of our countrymen and in any corner of our country. I earnestly hope that this may be done at no distant future

under the guidance of the Indian National Congress.

Dr N. G. Chatterji of the H. B. Technological Institute, Cawnpore, speaking on "Power Alcohol," said:—

The total annual production of molasses from the cane factories of India may be taken as 450,000 tons, so that the estimated annual surplus, after meeting the existing demands within the country put down at 175,000 tons, may be put at 275,000 tons. If the whole of this surplus molasses were converted into power alcohol, the available quantity of the latter- at 60 gallons per ton of molasses—would be 16,500,000 gallons. The present annual consumption of petrol in India is about 95 million gallons, so that on a 20:80 alcohol-petrol mixture basis, the requirement of power alcohol to make the mixed fuel would be 19 million gallons—in other words, a little more than the estimated production from surplus molasses.

Regarding the cost of production, it has now been amply demonstrated that in an efficient distillery this would be between annas five and annas five and a half per gallon, which is almost exactly the c.i.f. price of Burma petrol at the Indian port.

Apart from the use of alcohol in the mixed fuel, there is also considerable potential field for its use by itself in special alcohol engines and small power generators. It is therefore a matter for careful consideration to find out how far it would be economically and commercially justified to draw up a scheme for the utilization of hydro-electric power in Western U. P. for electro-chemical industries, near the generating stations, leaving power supply to distant small consuming centres to alcohol engines. It is estimated that with alcohol at annas six per gallon, the cost of power from alcohol engines would be within -/1/3 per K.W.H.

Professor Adarkar speaking on "The Need for Beneficent Legislation to ensure a Cheap Supply of Electricity in India said:—

In view of what the previous speakers have said, the question arises as to what is to be done exactly to bring about a speedy reform in the conditions of power supply in India. The chief aims of national electricity policy, as may be seen from experience in foreign countries, are generally as follows: (1) To protect consumers from the monopolistic exploitation in rates and from discrimination with regard to the quality and steadiness of supply; (2) to ensure a steady and adequate supply of electricity to industrial concerns, by integration of production and distribution—a part of a progressive policy of industrialization, as in the case of the English Grid System, or the integrated system of Germany; (3) to utilize and exploit the power of natural resources for the sake of the country's wealth, so as to reduce the cost of production to the minimum possible, and to conserve the national power resources, as in the Tennessee Valley Administration, the Boulder Dam in the United States and in the Speicherwerk in Germany, (in this respect, hydro is likely to prove more serviceable than thermal generation, for hydro power depends upon inexhaustible water resources provided by Nature); (4) to influence the business circles and solve the problem of unemployment, as we witness President Roosevelt's drive in America to abolish destitution and to raise standards of life, under the Public Utility Holding Law; and (5) to employ electricity resources as part of the economic policy of autarchy, implying military aims.

What is the position in India? In India not only is electricity production at a very low level, but the consumers are being systematically exploited by the monopolist companies, mainly of foreign incorporation or ownership. There are at present three main types of producers: Government or State projects, such as the U. P. Ganges Scheme, the Punjab Government's Mundi Scheme, the Mysore Government's Shivasamudram and Madras Government's Pykara Schemes, and the various projected schemes under construction; the great joint-stock concerns like the Tata Hydro-electric, the Andhra Valley and Tata Power Companies; and lastly, the small thermal stations owned by a host of private companies all over India. In spite of the fact that Governments have participated in the electricity production, the pace of rates is set by the Companies working under private licences and paying high dividends (10% or 12% in cases). High rates mean low consump-

tion and low consumption means again low production which implies high costs of production. The maximum rates laid down under the licences become the actual rates everywhere, while the consumers are exploited on all fronts, on meter rent, minimum charges, service rent, etc. Mismanagement, falsification of accounts, putting profits to open and secret reserves, high overhead costs due to forbiddingly high salaries of European officials—these evils are rampant everywhere costing the consumer heavily. No steps have been taken either by the Government of India or by the Provincial Governments to safeguard the consumer, whether domestic or industrial, from the rapacious methods of private companies. The recent tussle that is going on in Calcutta between the local Municipal Corporation and the Electricity Company and in which the Provincial Government has unfortunately been helping the Company, is an instance in point. It is the general anti-industrialization policy of the Government which is responsible for this state of affairs; the vast financial power of the vested interests is also a lion in the path of future progress. Cheap power is the basis of industrial regeneration in India, while the growth of electro-chemical and aluminium industries directly depends upon the development of our hydro-electric and other power resources. The Congress Governments could do a lot to remedy this state of affairs in the Provinces and take part in a progressive programme of utilization of available power wealth and of the control and co-ordination of power supply; but unfortunately even the Congress Governments do not seem to be yet alive to the importance of this basic industry. They are frittering away their energies on small things. They are counting their rupees, annas and pies, and are afraid of a dearth of money in the country, while countless men are lying idle, enormous power resources are lying unutilized and the industrial and domestic consumers are being exploited under their very noses by foreign companies.

The legal position as laid down by the Indian Electricity Act, 1910, amended several times, particularly in 1937, is that the power of granting licences is vested in the Provinces, while general directional power lies with the Government of India (now decentralized in the hands of the new Central Electricity Board). Under the new Constitution, electricity is a concurrent head, but the Federal Government will have only general, directional powers of legislation.

It is not the legal machinery, however, so much as the policy that matters in this respect. Legislation will be merely to empower and to give effect to policy. So far the general aim of policy has been to encourage private production and distribution under licences; there has been no idea of integrating, or cheapening, or of the conservation of power supply resources. The power of compulsory purchase has been latent but seldom used. There are two main practical steps which must be taken if India is to make any progress at all in power generation and not starve in the midst of plenty. (1) In the first place, it is very essential and urgent that the entire system of power supply in the country should be *nationalized*. This does not mean that the companies are to be abolished necessarily, but that they should be either bought up or absorbed and made a part of a big national venture or a group of provincial ventures. Their dividends should be limited or guaranteed on a sliding-scale basis inversely with the rates charged. Their production and distribution should be pooled into an enormous grid scheme which will enable the "pooling of the load." In any case, the present hegemony of vested interests must be broken up. Only a truly nationalized concern can create the possibility of basing rates upon expected future costs and adopt a far-sighted policy of rates, continually lowering them on the principle of increasing returns. Private companies have neither the time nor the inclination to wait for such long-run rewards. (2) Secondly, the Provincial Governments should immediately undertake progressive and nation-wide utilization scheme of power supply, after proper preliminary surveys to avoid and to investigate, incidentally, the mistakes committed by earlier unplanned schemes like the U. P. Ganges and the Punjab Mundi Schemes. The total electricity production of India can be increased hundred-fold, if this is done. Let the Congress make this question its own and ask the Provincial Governments to take a bold and forward step in nationalizing and rationalizing the country's power supply. Let

them appoint at an early date Electricity Commissions in each Province to suggest ways and means to bring about greater control, better co-ordination and increased production of electric power in the country.

Touching upon the question of Power Alcohol, Prof. Adarkar said that the scheme for mixing alcohol with petrol was quite attractive but the question was: who is to bell the cat? The petrol companies would not be very enthusiastic about it, for it was bound to cut into their sales of petrol. Moreover, power alcohol (as distinct from alcohol for human consumption) was a subject for Federal legislation, and the Provincial Governments had no power to legislate on it. There was little chance under the present constitution that the proposals in this connection could be given effect to by the Provincial Governments.

Dr G. R. Toshniwal speaking on "Electrification of Soviet Russia" said:—The level of electric power development in pre-Revolution Russia was very poor, it was decades behind the advanced countries of the world. The conditions in Russia during this period were very similar to those obtaining in India today. Nearly 70% of the population were agriculturists, and were almost as poor and ragged as the present-day peasants in India. The electrical equipment was inefficient, the cost per installed kilowatt and the cost per kilowatt-hour were extraordinarily high. The load factor being very low, the production cost averaged 2½ annas per unit, while in some cities it was as high as 6½ annas.

During the Great War and the Civil War, the power equipment of Russia was largely paralysed or destroyed. In 1918, when the country was ablaze with fires of civil war, Lenin requested the Russian Academy of Sciences to begin the scientific and technical study of reorganizing industry and effecting the economic recovery of Russia. Lenin emphasized the necessary of "paying especial attention to the electrification of industry and transport and to the employment of electricity in agriculture."

In 1920, a committee consisting of two hundred scientists and engineers headed by Prof. Krzhinzhanovsky was appointed for elaborating the plan of governmental electrification of Russia (Goelro plan). This plan was projected for 10 to 15 years, it provided for capital investment of 17,000 million roubles (about 2,500 crores of rupees), and aimed at an industrial production rise to 180%-200% of the pre-War level. For the fulfilment of the Goelro plan it became essential to make a very thorough survey of power resources—coal, peat, oil, shale, water power, etc. The surveys revealed that Russia's power resources were vastly richer than supposed; coal reserves were found to be 1¼ billion tons instead of the pre-War estimate of ½ billion tons; oil areas of minor importance were found to possess rich potentialities; the hydrological survey (consisting of 5200 stations) showed that 250 million kilowatts was a more correct estimate of Russia's water power capacity than the pre-War estimate of 14 million kilowatts.

The most important features of the Goelro and the two five-year plans are: (1) The centralization of electric power and concentration of generating plants in regional stations, interconnected into electric systems—the grid system. (2) Development of centralized combined production of heat and electrical energy. (3) The development of hydro-electric stations. (4) Fullest utilization of low-grade local fuel for electrification.

It might be pointed out here that economy has been the main factor in the Russian grid system. Electricity generated by whatever method has been connected to the grid system.

As result of this planned economy the production and use of electricity in industry has been very rapid in Russia. In 1928, just before the first five-year plan, the country's total generating capacity was 70% above the pre-War level, while the electricity output was 160% higher. The electrical equipment of the U.S.S.R. was 55% of that of Italy, 40% of that of France, 35% of that of England, 20% of that of Germany, and less than 5% of that of U. S. A. Even Switzerland generated more electricity than U.S.S.R. in 1928. The two five-year plans have however now radically changed all this.

The electrical energy used in industry in Russia rose to eighteen thousand million units in 1935—an increase of 650% over the figures of 1926. During the first five-year plan and the first

three years of the second five-year plan thousands of new industrial plants for manufacture of tractors, automobiles, heary iron and steel machinery, chemicals, cotton textiles, etc., were put into operation. In technical equipment several of these plants far outstrip similar European concerns.

Dr A. N. Tandon spoke on "The development of electrical power in the United Provinces." In the United Provinces the power was installed rather for agricultural use than for industrial purposes. The present state of electrical supply is very much antiquated in this province and the total consumption *per capita* comes to only 4 units per year. The supply companies in the province which have been entrusted to the hands of vested interests are making enormous profits at the cost of the country's industrial progress. The same could be said of the Ganges Canal Hydro electric Grid Scheme which has been brought about at a record figure of Rs 1204/- per K.W. installed, and was supplying energy at a high rate. Referring to the recent questionnaire issued by the Electricity Committee appointed in U. P., he said that it touched only the most insignificant problems and ignored the radical causes. What was wanted was a thorough examination of the question of co ordinated generation and distribution of electrical power with a view to providing a cheap supply of power in U. P.

The sponsors of the Ganges Canal Project would have done some service to the country if instead of trying to capture the public imagination by the idea of rural electrification, they had concentrated the load near the generating stations for development of heavy chemical industries. The Ganges Canal Hydro electric Grid generated electricity at .87 anna per unit which is almost twice the price per unit generated by long-haul coal, which is only .45 anna. The Eastern Grid and Pumping Project which has also been planned on the lines of the Ganges Canal Hydro-electric Project will also meet the same fate as the former on completion. It is, therefore, evident that the position of electricity generation and distribution in U. P. is very unsatisfactory and requires complete overhauling, to achieve which the Government should establish a power research organization for studying these problems and devise means to supply cheap power.

Pandit Jawaharlal Nehru in summing up the discussions said that there could be no two opinions regarding the necessity of establishing Power Research and Survey Institute with a view to ensuring cheap and abundant supply of power for the nation. The Congress is not blind to the urgency of the matter. But the conditions under which the Congress Government functions is not wholly understood. Democratic governments are greatly burdened by their ordinary routine work and complaints from innumerable persons who now have access to them. They must first do things which are demanded by hundreds of thousands, and have no time to listen to the counsels of a few dozen, however wise they may be. Further, the Government is so tired of listening to trivial matters, that they are jaded, and have little time to discuss far-off schemes with experts and scientists.

On the side of the Government, it can further be said that the expert scientist is not always a helpful person. He does not realize that things which have to be put before the government must be definite and must be related to what is actually happening. The proposals must fit in with the realities of the situation.

He would suggest to the Academy to draw up definite proposals, such as might benefit the nation, not vague aspirations as to what should or might be done.* Concrete suggestions should be given for power survey, to prevent exploitation of the public by the power supplying companies, and for the use of power alcohol. It has just been said that provincial governments can do nothing in the matter of power alcohol because it is a federal subject. He was not sure of that, but, in any case, we have to develop public opinion and put pressure on the Government. The Government of India is not so powerful as people think. It is a fading institution.

*Following Pandit Jawaharlal Nehru's suggestions, the National Academy of Sciences passed in their next meeting held on March 25, 1938, a few resolutions embodying concrete proposals as to what should be done. These are published in our section of "University and Academy News." —*Ed., Sc. & Cul.*

Fight of the Oxford Municipality against Lord Meston and Others

[The war of independence declared by the Calcutta Municipal Corporation in the matter of the City's electric power supply against the monopoly possessed by the Calcutta Electric Supply Co. has aroused widespread interest, and provoked comments, both friendly and adverse. This type of fight of the city councillors against monopolies held by big financial groups, though probably new to this country, is not unknown in England. The following article, reproduced from the "New Statesman and the Nation," of March 5, 1938, describes the struggle of the Oxford Municipality against a powerful financial group in the matter of the city's electricity supply. It will be interesting to note that Lord Meston who is the president of the Calcutta Electric Supply Co. figures very prominently in the Oxford City's struggle as well. Our attention to this article was drawn by Pandit Jawaharlal Nehru to whom our best thanks are due.

—Ed., Sc. & Cul.]

THE lessons of Socialism are often taught in a form so abstract that the layman fails to appreciate their relevance. The reason for this is very largely the difficulty of explaining in detail the working of the capitalist system without making oneself liable to actions for libel. Only rarely do facts come out which are both publishable and instructive. For this reason the history of Oxford City's electricity supply may well be of general interest. It is not an unusual history and it illustrates the conflict between the consumers' interests and the policy of high finance typical of our present economic system.

The Oxford Electric

Electricity arrived in Oxford on June 18th, 1892: it was generated and distributed by a small local company called Oxford Electric, whose shares were largely owned by citizens of Oxford. Whatever the virtues of private enterprise, they did not manifest themselves in this concern, but, in spite of its notorious inefficiency, Oxford Electric in 1924 extended its area to take in the growing industrial suburbs which were later to be included within the City boundaries. In 1932, after forty years of hard work, it could boast of the highest tariff in England and a partly derelict plant: there was practically no domestic development, and round about four cookers had been installed.

The City Municipality takes over Oxford Electric

Meanwhile a few intrepid spirits on the City Council had been urging that the service be municipalized, and in January, 1928, the City resolved that they would exercise their right of purchase for the area within their then boundaries. This did not include the new industrial suburbs where nearly half the inhabitants live, but the Council desired to buy this area too. If ever there was a case for public ownership it was here.

Oxford City's Struggle against Financiers

But by now the City was faced not by a puny local company, but by the serried (if confused) ranks of international finance.

(1)

The Wessex Company—Chairman, Lord Meston —had bought off 64% of the shares of

The Oxford City Electric Co—Chairman, Lord Meston

(2)

The Wessex Co. is controlled by Edmundson's Ltd.,

FIGHT OF THE OXFORD MUNICIPALITY AGAINST LORD MESTON AND OTHERS

(3)

The Edmundson's Ltd. is controlled by Greater London and Counties Trust.

(4)

The Greater London etc. is controlled by a Canadian Trust.

(5)

The Canadian Trust is controlled by a Public Utility Company in the U. S. A.

This financial pyramid was resolutely opposed to the idea that Oxford City should try to provide electricity at tariffs which its citizens could afford. An influential Tory councillor had been appointed a director of Oxford Electric; another director was instructed to negotiate, failed, retired and received £6,000 for " loss of office "; and, finally, our financier thought fit to indulge in three years of litigation to prevent the purchase.

Oxford Municipality wins the Case

This litigation was rendered even slower than usual by *the necessity of referring every detail to a mysterious gentleman in Chicago;* but Oxford City, with a fool-proof case, held out in spite of well-organized inner opposition right to the House of Lords, and in 1932, after enormous expenses had been incurred, the inner area came under the control of the City. Purchase of the outer area was impossible.

Achievement of the Municipality—Rates Decrease to One-third

Between 1932 and March, 1937, municipal enterprise succeeded in revolutionizing Oxford's electricity supply. The number of consumers rose from 5,800 to 13,500, and the consumption from 6,952,680 units to 27,429,228, while the average price per unit decreased from 3.84 to 1.26 pence. By January, 1938, instead of four cookers there were 3,620, instead of no water heaters and boilers there were 4,180. Moreover considerable profits were shown, which, instead of disappearing to Chicago, could be used for the benefit of the ratepayer.

Electricity Supply in the Suburbs

But the delays of litigation had produced a curious situation. Even before the City took over the inner area, it had extended its boundaries to include the industrial suburbs, so that from 1932 on ratepayers in three large wards were suffering under the commercial tariffs extorted by the Oxford Electric far higher than those prevalent in the inner area, and Headington and Cowley began to demand that Oxford City must extend its supply at least to its own ratepayers in industrial Oxford. Though this was obviously to the consumer's interest, it became clear in 1936 that the MacGowan Committee's Report threatened to throw Oxford back to the financial lions. The Wessex, which had been in control of the old Oxford Electric, was larger than Oxford City and the report recommended the absorption of the smaller distributors by the larger. Those fears were somewhat allayed by the White Paper which suggested that in the reorganization, Oxford should take over its outer area; but the White Paper is not an Act.

Intrigues of Financiers

The White Paper galvanized the financiers into activity. A furious jockeying for position took place in the winter of 1937. All parties tried to strengthen their position before the Government legislated. The moves in this game merit the attention of all students of modern life. As a respectable banker said in Council " If the Labour Party knows how to use this, it is worth a hundred seats." I hope he is right, for here are the facts.

Lord Meston's Dealings

Early in December, 1937, Lord Meston Chairman of the Wessex most of whose shares are held by Edmundson's of their nominees makes an offer to

Lord Meston—Chairman of the Oxford Electric, 64% of whose shares are held by the Wessex.

This offer, approved by the Electricity Commissioners, was for the princely sum of £240,000 as from July 1st, 1937. It is worth noting first that this offer was made at a time when the Council was dispersing for its Christmas holidays, secondly that the Council was not informed, and

thirdly that the shareholders were led to believe that the offer was a generous one which they would do well to accept. That at least was Lord Meston's view, and he was in a position to know as he was in a sense both purchaser and vendor.

Fight of the Municipality against the Financial Pyramid

A shareholder of Oxford Electric informed the then chairman of Oxford City Electricity Committee that these negotiations were pending. He was surprised to learn that the sale was taking place behind his back. With considerable courage, being unable to get a resolution of Council in time, the chairman on his own initiative wrote to Oxford Electric that the City would offer substantially more than £240,000. This letter was read at the meeting of shareholders, and compelled Lord Meston to adjourn the meeting. From the point of view of the consumer, it is interesting to note that he was advised to accept a low offer on the superb ground that public utilities should not be put up for auction. From the point of view of public control, furthermore, we should observe that the Electricity Commissioners sanctioned this inter-company deal and have indicated that no useful purpose could be served by hearing a deputation from the City Council whose citizens' electricity supply is at stake.

Fight between Oxford Municipality and Financiers

In January, 1937, Oxford City Council unanimously approved an offer of £300,000, and guileless citizens believed that all was well. But Edmundson's, or rather Imperial Continental Gas (for yet another transaction had now taken place, and this patriotic British group had now replaced the Canadians and Americans in control), had one or two cards up their sleeve. In letters to the sharesholders Lord Meston coolly argued that Oxford's £300,000 was worth less than £240,000 as Oxford proposed purchase from April, 1938. When it had been shown that Oxford was really offering £60,000 more than the Wessex, Lord Meston went on to state that Edmundson's were now willing to add £65,000 to the purchase price offered by the Wessex, and the shareholders' meeting of Oxford Electric approved the purchase. This approval was not difficult to obtain since 64 per cent of the shares were held by the purchasers!

Again let us consider the situation. The directors of Oxford Electric (chairman, Lord Meston) strongly recommend the acceptance of an offer of £240,000 from the Wessex (chairman, Lord Meston). When Oxford offers more, the first offer is brought up to £305,000 by a gift from Edmundson's Ltd., who controls the Wessex, and this gift proves at least that the same people advised Oxford Electric shareholders in December to accept £65,000 less than they were one month later prepared to pay. Not doubt this is normal etiquette in the financial world, but it looks strange to those of us who are used to more humdrum business methods. Even stranger is the fact that the consent given by the Electricity Commissioners to the first offer holds good in spite of all these transactions. They had sanctioned purchase at £240,000 presumably on the ground that it is no concern of theirs if somebody else likes to add another £65,000 even though this "somebody else" is in fact the same concern under another name.

The Fight Continues

But to continue our story: Oxford City is now promoting a Bill, at very great expense, to bring the Oxford Electric Co. under its own control. Local "non-party" petitions are receiving the kindest consideration by local Conservative M.P.s. who under pressure of public opinion are forced to condemn the whole proceedings and to give their fervent support to municipal Socialism. Oxford is a city united in its detestation of monopoly capitalism in so far as its operations affect its electricity.

It is hoped that the Bill may get through. But meanwhile the Wessex has magnanimously offered to complete its operations by buying the municipal undertakings as well. And I have no doubt that it has more influence with the National Government than Oxford's gallant—if tardy—local M.P.s. Meanwhile, similar measures are being taken by

the great power concerns throughout the country, or rather (in General Franco's language) they are now mopping up the remnants of electrical Bolshevism which survived their campaign of the last ten years. When this has been done and the great interests have fortified their positions securely, the Government will produce its Bill for the regulation of electrical distribution in Great Britain.

R. H. S. Crossman.

(From *The New Statesman and Nation*, March 5, 1938)

More about the Calcutta Electric Supply Corporation

The above history of the Oxford Electric will be found interesting to everybody. It provides only one among hundreds of thousands of instances to expose how capitalistic methods work.

The public may be interested to know more about the Calcutta Electric Supply Co.—the following details (complete details up to Dec. 1936) are taken from the *Electrical Times*. Only round figures are given.

Capital of the Company	Seven million pounds sterling.
Population served ..	16 lacs.
Total Gross Revenue ..	1.23 millions of pounds plus £49,910 in meter rents.
Working cost ..	Nearly half a million pounds.
Gross Profit (minus interest on loan, depreciation).	Nearly 7.77 lacs of pounds, *i.e.*, 11% on capital.
Interest	1.46 lacs of pounds.
Depreciation charges	2.90 lacs of pounds.
Total Power installed	105000 kilowatts.
Total amount of electricity manufactured.	311 million units, *i.e.*, 177 units per head in the year, of which 36 is domestic, 143 industrial.
Total number of consumers.	68582

The cost of production and marketing amounts to .39*d* per unit, *i.e.*, a little over 1/3 of an anna calculated as follows:—Coal, salaries etc.—.30*d*; repairs, maintenance, store .01*d*, management .08*d*.

The company charges on the average .95*d* per unit, but this includes power. For domestic purposes the charge is 2 annas or 2.25 pence which is nearly 5 times the cost of production. The ratio of the charge for domestic supply to the cost in England appears to vary from 2 to 3 so that the company is not justified in charging from the domestic consumer more than an anna. According to our estimate if the Corporation buys up the interests of the Calcutta Electric Supply Corpn. it will, like the Oxford Municipality, be able to bring down the rate from two annas to one anna, and still give a handsome profit to the Calcutta Corporation. The profits of the electrical undertaking, instead of disappearing into spacious pockets of the international financial magnates, may be utilized for improvement and amelioration of the City.

Notes and News

Flood Control Research at Cornell University

Flood control measures for the southern tier counties of New York State and the adjoining counties in northern Pennsylvania are under intensive study at Cornell University by the War Department, the School of Civil Engineering cooperating. Benjamin K. Hough Jr., of the U. S. Army Engineering Corps, has a staff of 35 men working in Ithaca on problems of soil mechanics. A. N. Vanderlip with Professor Ernest W. Schoder and other members of the Cornell Engineering faculty are conducting research in Hydraulics. The War Department is making extensive use of Hydraulics Laboratory of the College of Engineering and has erected a new soil mechanics laboratory, equipped with two car-loads of apparatus from the abandoned Passamaquoddy Dam project in Maine.

Research is proceeding in two major directions: problems in channel improvements, construction of check dams and other water control measures; and studies of foundation conditions and suitable materials for earth embankments and earth dams where needed. The first important problem in hydraulic group necessitated the construction of a scale model of the Chenango River through Binghamton, where disastrous floods occurred in 1935 and 1936.

The model, constructed in the Belbe Lake canal above the Hydraulics Laboratory and built to exact scale of 12 inches to 75 feet, has made possible studies of the Chenango River for two miles above its junction with the Susquehanna. The flow of water in the model is regulated in proper proportion to that in the river for its various flood stages and is measured and recorded very accurately for flood control study.

A serious difficulty has been to secure accurate data to guide the operation of the model. Few reliable records were made before the flood of July 1935. The preliminary tests had to be run under three conditions: (1) with the river partly blocked by sections of the bridge as immediately after the flood, (2) with the river flowing freely under the new bridge, (3) with the river partly blocked in a different way by contractors' trestles for the river bridge. Now that the reliability of the model as an accurate reproduction of the river to scale has been established, each test still has to be done three times, with different levels of flow in this Susquehanna.

Careful experimental studies have shown the probable effects of a number of proposed channel improvements designed to lower the Binghamton flood stage at least a foot—a margin which would have had important beneficial effects during both the recent floods.

Most of the dams and embankments to be constructed will be of earth. Hence the properties of the earth to be used assume great significance. Samples from various sites are under continuous scientific study. On the basis of these tests, army engineers are selecting sites and designing structures which will eventually control the flow of water through the entire Susquehanna valley, and will, it is hoped, completely eliminate the danger of serious floods in the future.

—*Science*, March 1938.

The Enquiry Committee's Report on the Bihta Railway Disaster

The Bihta railway disaster which occurred in the third week of last July was the most serious of its kind in India. According to the official estimate, 107 persons were killed and 117 injured as a result of the accident. A committee was set up with Sir John Thom, Chief Justice of the Allahabad High Court, to enquire into the causes of the accident, and the report has recently been published. According to it, " the derailment of the 18 Down near Bihta on July 17, 1937 resulted from distortion of the track which was caused by XB class engine No. 1916 running at excessive speed and hunting." The accident is therefore directly attributed to the negligence on the part of the Railway authorities. The Railway Company is accordingly, says Sir John in his report, liable

to pay damages to those who were injured and the dependants of those who were killed in the accident.

In course of the evidences before the Enquiry Committee, much stress was laid on the XB type of engines as being dangerous for use. More care and greater discrimination is expected of the railway staff in the employment of the engines, and their selection should be, in every case, strict and rigorous, besides maintaining very careful vigilance over every possible source of danger. The risk of railway travel may thereby be greatly minimized though not absolutely eliminated.

First All-India Electrical Conference

We are not aware if any electrical conferences were held in India in the past, though need for these must have been felt in some quarters with the development of electrical industry in this country. The first All India Electrical Conference that held its session at Calcutta during the Easter vacation must have therefore been very welcome. It is in these conferences that experts meet and exchange notes, not only to their mutual benefit but also to the great advantage and development of the industry concerned, besides creating a strong public opinion in favour of the decisions taken in the conference. The first All-India Electrical Conference was opened by the Hon'ble Mr N. R. Sarker, Finance Minister of Bengal and presided over by Mr. J. N. Mukherjee, formerly Chief Electrical Engineer, Posts and Telegraphs, Government of India. Mr Sarker in his opening speech emphasized the need of developing electric power in India for the economic benefit of the country. The main reason, said Mr Sarker, for India's backwardness in the matter of electricity consumption was the want of adequate recognition so far by the public, as also by the Government, of the great utility of electrical power for the economic development of the country. But, he proceeded, today there were earnest and persistent demands from the public for more and more development of electrical power. Enterprises were already in the field, and with the cooperation and encouragement of the Provincial Governments these enterprises would be productive of immense benefit to the nation. Mr Mukerjee, in his presidential address, advocated the adoption of the grid system on the lines of the United Kingdom with such changes and modifications as would be in conformity with the physical and climatic conditions of India and the establishment of a properly equipped scientific and engineering research department for the development of the resources of the country on sound commercial and scientific lines.

Important Resolutions of the Electrical Conference

The All-India Electrical Conference passed a resolution requesting the Government of India to appoint a committee of experts to go into the question of industrial and rural electrification for the development of the latent resources of the country and to formulate schemes for the installation of a national grid system in every autonomous province of India. The Government of India was also asked to take up, in consultation with provincial governments, the question of establishing a department for scientific, industrial and engineering research, similar to the Department of Scientific and Industrial Research established in the United Kingdom in 1916. The Conference also requested the Government of India to subsidize deserving persons or firms who undertook to manufacture electrical machinery and other products against proper security, and to electrify the railways where such electrification proved to be more economical than the present system.

The Conference requested Indian Universities to include in their curriculum for the matriculation or school final examination elementary lessons in electricity and its application for domestic and other purposes, and urged the Central Government to make a survey of the coal resources of India to determine the possibility of preserving them for industries that needed coal and also of economy in their use. It also drew the attention of the Government of Bengal to the report of the Hydro-Electric Survey of India about the possibilities of the power resources of Bengal, and urged that speedy effect be given to it with a view to developing such resources for the benefit of the province. The Conference requested the Government to fix cheaper freights for the carrying of coal, oil and other necessities for electric supply companies in order to enable them to generate and supply electricity at a cheaper rate, and also to employ trained Indian electrical engineers, as far as possible, in the future. The Conference formed a sub-committee to consider whether 230 volts (A.C.) supply is suitable and safe for domestic use

or whether further restrictions should be imposed to render it safe.

Need of Research in Indian Medicines

Presiding over the annual convocation of the Unani Tibbi College, Delhi on April 9 last, Sir Shah Mohammad Sulaiman urged the desirability of greater use of indigenous systems of medicine. The Indian medicines are no doubt cheaper, as they are produced locally, and there are also among them a rich stock of medicines of well tried efficacy. But there has not yet been any uniform standard of these, nor can they be called safe and reliable. Sir Shah Mohammad therefore strongly emphasized the need of research and original investigation on modern and scientific lines in order to develop the Unani system. The same may be said of the Ayurvedic system also. Both these systems unfortunately suffer from a lamentable lack of originality, so far as the teaching of pure science is concerned.

"The deplorable practice of accepting the ancient books as the last word on the subject has brought about stagnation, and made Indian medical knowledge almost stationary. By an abject submission to some out-of-date ideas and an implicit acceptance of old authorities, the Indian systems ignore that medical science has undergone a complete revolution as a result of new discoveries. If the Indian sciences are to maintain their existence and to advance with the Western science, they must incorporate all the modern researches of the West and readapt them for their own use."

He also emphasized the necessity for co-operation among *vaids* and *hakims* so that any additional knowledge gained may become the property of all. "Unless unregistered practitioners are prohibited by Statute from carrying on medical profession, the public cannot be safe from being entrapped by such quacks with impunity, as there is utter ignorance of the legal right to claim damages for injury caused to health by wrong treatment. Lastly there should be an effective guarantee that druggists supply pure and unadulterated articles, strictly according to prescriptions, and this can be achieved by strictness in the grant of licenses, and by constant supervision of druggists' shops. The present state of affairs is that the Western doctors treat the Indian sciences as antiquated and worthless, while the Indian physicians treat the Western sciences as somewhat undesirable and useless innovations. Both should recognize that so far as old medicines and prescriptions are concerned, the Indian sciences possess them in plenty, and have demonstrated their efficacy. But the Indian science of medicine and surgery is professedly antiquated, and has admittedly not kept pace with the advance of the European science. Only a proper co-ordination between these different systems can help to make a valuable contribution to the advance of human knowledge, and be of everlasting benefit to humanity."

Prof. D. M. Bose and Prof. M. N. Saha

As announced in our last issue, Dr Debendra Mohan Bose, Palit Professor of Physics, University College of Science, Calcutta, has joined the Bose Institute as its Director, in succession to the late Sir Jagadis Chandra Bose. Dr Bose joined the Calcutta University in 1914 as Sir Rashbehari Ghose Professor of Pure Physics. For twenty years he held that appointment and in 1934 he succeeded Sir C. V. Raman as the Palit Professor and was also elected Head of the Physics Department of the University College of Science.

In Prof. Bose the University of Calcutta loses a capable teacher and a reputed scholar. His depth of scholarship, admirable thoroughness and methodical ways of teaching early marked him out as a singularly successful teacher. In the domain of original research also he earned great distinction. In his laboratory in the University College of Science important researches on radioactivity, magnetism and other allied phenomena were carried out by a band of his enthusiastic pupils. His contributions to the theory of paramagnetism and problems relating to molecular structure earned for him a wide reputation and undoubtedly added to the fame of the institution to which he so long belonged.

His wide experience and familiarity with impor that research institutes abroad will prove to be of great benefit to the Bose Institute. We hope that through his initiative and under his able guidance many new important lines of research will be developed there and the large resources of the Institute will be fully utilized.

We understand that Prof. Meghnad Saha will shortly join the University of Calcutta as the Palit Professor of Physics. Prof. Saha is not unknown

to the Calcutta University. Besides being one of its most distinguished alumni, he served this University for six years (1916 to 1923) first as lecturer and then as Professor of Physics, before he left to join the Allahabad University. It may be noted that his brilliant researches on thermal ionization which won for him world-wide reputation as a theoretical physicist, were carried out while he was a member of the staff of the University College of Science in Calcutta. Naturally his alma mater will heartily welcome him back.

As a teacher and original investigator, Prof. Saha has achieved unique distinction, and from his laboratory Allahabad have come out a band of scholars who have made noted contributions to theoretical and experimental physics. Prof. Saha will surely keep up this tradition in Calcutta and we have no doubt that his pupils here will be benefited by his rare intellectual gifts and energy.

Indian Museums Conference

The publication of the *Museums of India* by Messrs S. F. Markham and H. Hargreaves exposed in plain and straightforward language the absolutely sad plight in which the museums are to be found in this country.' While they are centres actively spreading and popularizing knowledge in the advanced countries, they are in India storehouses not of knowledge but of curios alone, and as such, they exhibit ancient objects of interest which the visitor may come and see. The true functions of a museum which are chiefly educational and cultural seem to be completely overlooked in India, where they are mainly meant to house collections of weird and curious objects, especially ancient. The authors of the *Museums of India* very strongly criticized the functioning of an Indian museum. We should, in this connexion, draw the attention of the reader to our editorial article, "Museums in India," published in the July issue (pp. 1—4).

Recently a Museums Conference was held at Delhi, in which important resolutions dealing with the working of a museum in India were passed. We reproduce below some of the most important ones of these:

"An essential part of the activities of a museum is the advancement of knowledge through investigation and research, and it is essential, therefore, that the authorities responsible for the different institutions should make adequate provision to facilitate such activities. The adoption of this policy implies the division of the collection of the museum into (*a*) display and (*b*) reserve study collections, both of which are essential if the institution is to fulfil its purpose."

"This Conference agrees with the authors of *Museums in India* that museums progress depends primarily upon the calibre, training and status of curators. It, therefore, reaffirms Resolution XV of the Museums Conference held in Madras in 1912, which reads as follows:—

'That the Conference desires to express in the strongest possible manner its conviction that the different branches of provincial museums should be under expert management, and that no exhibition of specimens can have much educational value unless it is arranged and supervised by a man who has made a special study of the class of objects of which it consists.

'The position of curators in India is far from satisfactory. Practically no arrangements exist anywhere in the country for their training, while facilities or opportunities are rarely provided for further training or studies, the visiting of other museums for gaining first hand knowledge of the advances made and the programmes of work followed for making such institutions more efficient and useful. In view of the above, the Conference recommends that arrangements be made for (*a*) the initial training of curators by starting in the larger museums of the country training centres in various branches of museum work; (*b*) refresher courses at regular intervals; (*c*) facilities for curators to visit other museums in India from time to time, and in special cases for the grant of leave for study in foreign museums; (*d*) setting up an expert Committee on museums to advise in regard to the qualifications and training of curators and other cognate subjects.' "

"The Conference further most strongly recommends that curators should invariably be *ex-officio* members of any committee of management of their museums."

"This Conference entirely agrees with the authors of *Museums of India* that the funds provided for the maintenance of the museums of the country are

inadequate and much lower than is warranted either by population or by revenues. A large part of the criticism found in the report can admittedly be traced to insufficiency of funds. The Conference therefore urges the various provincial Governments and the local bodies concerned to arrange for more adequate financial provisions at the earliest possible time. The provision of museums in some of the largest cities which still lack them is an urgent educational need, but cannot usefully be considered till the necessary funds are likely to be forthcoming."

"This Conference considers that, with a view to increasing the educational value and public interest in the museums of the country, special efforts should be made to bring the general public into closer contact with them. Definite provision should, therefore, be made for the various classes of visitors. Since the majority are illiterate, and can, therefore, best be reached through exhibits explained by the spoken word, it is essential that special guide-lecturers should be provided. For the general visitor the Conference recommends the preparation of inexpensive, outline guides in English and the principal local vernaculars, reviewing, and as far as possible illustrating, the objects of outstanding interest in the whole museum in the case of specialized museums and in each section separately in the case of general museums. For the more educated public, including scholars of secondary schools, simple but more detailed guides will be necessary. The cost of publication should be accepted as a legitimate charge on museum funds. The Conference further recommends that public interest in museums be stimulated by establishing a closer contact between them and the Press, and, as far as possible, by lectures, broadcast talks, etc."

Report of the Survey of India

According to the general report for 1937 of the Survey of India, Geodetic operations including miscellaneous computations and research, astronomical, magnetic, seismological, and meteorological operations, the measurement of geodetic bases, principal triangulation, precise latitudes, longitudes, gravity determinations, and prediction of tides at Eastern ports between Suez and Singapore were carried on during the year. These operations are fully described in the annual Geodetic Report of the Survey of India, 1937, which will be published shortly. The maps published by the Survey of India during the year include topographical maps on scales of ¼ inch, ½ inch, and 1 inch to a mile, geographical maps on scales of 16 and 32 miles to an inch, and special town, guide, province maps, etc. The total number of maps (including revised editions, new editions, and reprints) published during the year was about 700 and their location is shown in various indexes included in the Report. A portion of a half-inch sheet falling in the Bombay Presidency is reproduced in the Report. In addition to these departmental maps, numerous maps and plans were prepared for the Army, local governments, railways, and various other departments. In the Mathematical Instrument Office of the Survey of India, apparatuses of various kinds were constructed and repaired both for the Survey of India and for other Government Departments—Army, P.W.D., Railway, Medical, Forest, Education, etc. Such articles as mathematical scales of all sorts, clinometers, protractors, levels, levelling staves, prismatic compasses, planetables, pantographs, head stereoscopes, folding mirror stereoscopes, lenses, prisms, thermometers, hydrometers, and measuring glasses were among the items manufactured during the year.

During the year under review, topographical operations included the original survey of 30,392 square miles on various scales, exclusive of an area of 3,931 sq. miles surveyed in Burma. The total area surveyed within the external limits of India up to the survey year 1936-37 was 1,140,073 sq. miles and the balance remaining for survey is 182,817 sq. miles.

Surveys in the Himalayas included the area between the Alakananda Valley and Badrinath, and the Dhauliganga and the tributary valleys as far as the Niti Pass on the Tibetan border. A private survey expedition organized by Messrs Shipton and Spender with the assistance of grants from the Royal Geographical Society and the Survey of India surveyed a larger area in partly unexplored country on the northern slopes of the Karakoram and in the Aghil Range. Their work forms, says the report, a major contribution to the cartography of this little known region.

All-Bengal Teachers' Conference

The All-Bengal Teachers' Conference opened its seventeenth session on April 16, 1938 at Khulna. It was attended, it is reported, by five hundred delegates

representing every district of Bengal. Professor Radha Kumud Mookerjee, of the Lucknow University, presided. Mr N. N. Sen, M.L.A., who was the chairman of the Reception Committee, touched, in his address, on some important questions relating to secondary education, now agitating the mind of the public. The President in his address dwelt on the drawbacks of the secondary educational system existing in this country and said *inter alia*: "Of all the schemes of educational reconstruction so far proposed, the Wardha Scheme sponsored by Mahatma Gandhi naturally occupies the foremost place in public attention. The fundamental principle of the scheme is that education should relate itself to a practical scheme of productive work and should centre round a craft to be able to 'educe' or draw out those latent capacities which make the integral man. Without this discipline of practical, responsible or productive work, education will become unduly abstract and theoretical and will not fulfil its real purpose of imparting life to education." Dr Mookerjee emphasized the need of vocational schools, which were not isolated growths in Japan, but were originally related to the economic and industrial life of the country. Introduction of vocational schools, he said, was to be determined on the basis of certain theoretical and scientific principles established by the science of pedagogics. He also strongly deprecated the grossly inadequate expenditure of the Government of Bengal for education. In his annual report the Secretary of the Association narrated its activities during the year, and the progress it had achieved during the past 17 years. He very much deplored the clauses of the proposed Secondary Education Bill of the Government of Bengal, whose purpose was to control and not improve education.

Report of the Botanical Survey of India

The annual report of the Botanical Survey of India for 1936-37 shows that 3,500 specimens were identified during the year, the major portion of the collections coming from the Sikkim and Bhutan Himalayas, which are even now *terra incognata* botanically. There was an unusually large number of specimens on loan, both inland and overseas. An interesting acquisition to the herbarium is a sheet of the aquatic *Aldrocanda vesiculosa* Linn. collected from Vikrampur. In regard to exhibits of flora in the Indian Museum, the report states that 341 specimens were added during the year, obtained from South India, the United Provinces and Bombay Presidency, and consisting mostly of fibres, species, oil seeds, and medicinal plants. The Government of Burma having decided to close down their plantation all mature cinchona bark amounting to 181,894 lbs. was despatched to the Mungpoo factory. The sale of quinine sulphate tablets dwindled from 1,222 lbs. to 339 lbs., and that of cinchona febrifuge tablets rose from 155 lbs. lbs. to 1,422 lbs. This change may be attributed to the comparatively low price of cinchona.

Symposium on India's Power Supply

Several times in these columns we have dwelt on the question of India's power supply. In the last and present issues there has appeared an article titled "An intelligent Man's Guide to the Economics of Power Supply" by Prof. Saha and Dr A. N. Tandon, in which the subject has been very lucidly treated so that every educated reader may understand it clearly, and with profit. In the last annual meeting of the National Institute of Sciences Prof. M. N. Saha devoted a good deal of his presidential address to this problem, which also formed the theme of our editorial for February. On the 5th March last a symposium on India's Power Supply was held under the auspices of the National Academy of Sciences, India, at Allahabad. Many distinguished scientists participated in the discussion, Pandit Jawaharlal Nehru presiding. The question of India's Power Supply was thoroughly thrashed out, and the speakers were all unanimous in emphasizing the urgent need for tapping all the national resources of the country for the development of power in this country. We publish elsewhere a detailed report of the symposium with the summaries of the speeches of some of the participants and the comments of the President on it. While admitting the need for an investigation into the question and an early development of power resources of India and establishment of a Power Research and Survey Institute, Pandit Jawaharlal Nehru, suggested to the Academy to draw up definite proposals such as might benefit the nation, not vague aspirations as to "what should or might be done." In the subsequent meeting of the Academy, therefore, certain resolutions embodying concrete suggestions were passed. These are also published in our Section of University and Academy News.

Science in Industry

The Hydroelectric Power Stations of Norway

In comparison with different countries, Norway is very favourably placed regarding its hydraulic resources. A territory of three hundred and twenty-three thousands sq. Km. can supply hydraulic power amounting to 9 million kilowatts rising up to 13 million kilowatts; and further it does not take into account any of the water-falls having a capacity less than 1000 H.P. At present 1.9 million kilowatts have been harnessed from this water-power amounting to 640 watts per individual.

The exceptional suitability of the water power is not only due to abundant rainfall, but to the large number of lakes situated high up on the mountains which are fed by eternal glaciers. These lakes are not far away from the Norwegian fiords and owing to the influence of the gulf-streams these fiords are navigable all throughout the year. So the economic condition of hydroelectric power generation is indeed very favourable for the country.

Norway has developed on a very large scale electro-chemical industries, the production of nitrates and other nitrogen compounds from atmospheric nitrogen. Birkeland Eyde Process for the oxidation of atmospheric nitrogen with the help of an arc controlled by a magnetic field is developed at Saaheim and the factory at Rjukan manufactures ammonia by electric process from electrolytic hydrogen secured from neighbouring factory of Vemork where 20,000 Cu. m. are produced hourly. At Rjukan, Haber process is also used with a pressure device of 250 K.gm./cm^2. Part of ammonia is liquefied as a commercial product and the rest is mixed up with oxygen and alowed to circulate through tubes containing incandescent platinum wire. The nitric acid thus produced is utilized either as Sodium Nitrate or as Calcium Nitrate according to demand. The annual production of the Rjukan factory alone is 200,000 tons.

The factory at Odda has developed the method of Frank and Caro to produce Calcium Cyanamide from Calcium Carbide at high temperature. The Norwegian product in 1934 amounted to 46,000 tons.

Norway has developed the production of aluminium to the extent of 40,000 tons annually. At Oslo, at Soelgen and at Jorpeland electric furnaces are active throughout the year for the production of alloy steels, such as Vanadium steel, Tungsten steel, Chromium steel, in large quantities.

In 1934, the electrochemical industries and electro-metallurgical industries exported materials worth 154 million Norwegian crowns and employed 60,000 labourers. It further sells a large amount of electrical power to the neighbouring state of Denmark where power is transmitted through submarine cable at 50,000 volts.

It is note-worthy in this connection to state that practically 80% of its machineries and plants have been developed in Norway so that the cost of production and installation is kept within a very reasonable limit.

Possibilities of Drug Industry in Assam

Speaking at the Shillong Health Exhibition, Mr P. Das, Vice-President of the Assam Chamber of Commerce, drew attention to the immense possiblities of starting profitable by-product industries in Assam from the sugarcane plantation. The soil and climatic conditions in the province are very favourable for sugarcane plantations which should be started to meet the local requirements. From the molasses left over after the extraction of sugar, a large quantity of alcohol could be obtained if a modern distillery could be attached to the sugar mill.

This cheap alcohol could in turn be utilized for the manufacture of such useful products as chloroform, ether, methylated spirit, rectified spirit and all the medicinal tinctures, spirit, extracts, etc., of the pharmacopoeia. Other profitable by-products would be perfumery products, caffeine (from the large quantity of tea sweepings, fluffs, etc., that were at present destroyed in the tea factories of the province for fear of these being used as adulterants for tea, while some were exported to America for the manufacture of

caffeine), quinine and its salts, cinchona febrifuge and emetine from ipecacuanha. Many indigenous and pharmaceutical drugs, as well as important oil-bearing seeds that were lying waste at present in the province, could be profitably extracted and supplied to the manufacturers not only in other parts of India but also all over the world where the demand existed for such products in concentrated and standardized form. This line could open up for the province a very profit able export trade, bringing in a large amount of wealth for the people of the province; but this was possible only if the Government of the province came forward and sincerely assisted private enterprise by means of a subsidy, and by other means as was done in Indian States.

Mr Das also referred to the eucalyptus and pine trees, which grew in the hills, and said that eucalyptus oil, pine oil, turpentine oil, resin, varnishes, and paints could be manufactured out of these raw materials, as was done on a large scale in the Nilgiris, Upper India and elsewhere and which brought in considerable wealth for the people of the provinces concerned. Other interesting exhibits shown by Mr Das were Cherrapunji coal and its valuable by-products, like coal tar, heavy and light creosote oils, benboine, carbolic acid, ammonia, ammonia sulphate, disinfecting fluids, lysol, napthaline, coal tar dyes and synthetic perfumes and chemicals.

Glass Industry in India

In his speech before the Rotary Club, Calcutta, on the 10th April last, Mr D. N. Sen, President of the Glass Manufacturers' Association, Bengal, made a strong appeal for adequate protection by Government to the glass industry. This industry in India has always been dogged by misfortune. The various factors contributing to its failure were analysed by Mr Sen to be incompetence of organizers, lack of expert knowledge, inefficient technical equipment and paucity of enough capital, which are mainly responsible for lack of improvement of the industry. Again there was foreign competition for which the indigenous industry had suffered a good deal. The tariff board examined the position of the industry in 1932 and recommended that adequate protection should be given to it by the Government at least for a period of ten years. The recommendation went unheeded, but Mr Sen emphasized, " protection against competition from foreign countries is essential if we have to exist. It is not merely that this competition has deprived us of our profits on our working, it often compels us to sell our goods even at a loss that we may retain in our markets." Protection—and adequate protection at that—by the State is necessary for the encouragement of an industry. Otherwise it can hardly thrive. The argument advanced by some people that perfection of the technique of production would of itself meet the foreign competition and should therefore be first aimed at is hardly tenable especially in the case of a new industry which has behind it neither the experience of a long past, nor the solidity and advantages of an established industry. If no preferential treatment is allowed to it by the State, it dwindles away, and eventually dies out.

Our Industrial Articles for May

This month we publish as our articles in the Science in Industry Section " Manufacturer of Patent on Proprietary Medicines " by Prof. M. L. Schroff and " Alumina and Cements from Waste Slags " by Messrs Y. P. Varshney and M. L. Misra. In the former article Professor Schroff dwells on the question of all kinds of so-called patent medicines, generally of poor quality and without any uniform standard, which are flooding the Indian market at present. The public is being exploited by the foreign as well as the native manufacturers by the sale of such patent or proprietary medicines. The author studies this question in the article and suggests remedies as far as possible. In the second article, Messrs Varshney and Misra show how the large amounts of furnage slags that are invariably thrown out in all iron and steel plants can be utilized for the manufacture of such substances as cement, etc.

Manufacture of Patent or Proprietary Medicines

M. L Schroff

Professor of Pharmaceutics, Benares Hindu University, Benares.

India is at present flooded with all kinds of so-called patent medicines. Many indigenous and foreign manufacturers aim at marketing only such medicines as will bring them more money in business, regardless of the ethical value of such practices. It is important for us first to see what is meant by proprietary medicines and secondly to study how the Indian public is being exploited by the foreign as well as the indigneous manufacturers by the distribution of these patent or proprietary medicines and to suggest remedies for the same.

The meaning of the terms "proprietary and patent medicines" is very confusing and even the pharmacy acts in various countries make matters worse confounded. There is a lot of agitation going on in U. S. A. at present to limit the use of these terms. Before the advent of large manufacturing concerns, the terms "patent and proprietary medicines" were synonymous, and they implied medicines manufactured by a manufacturer for self-medication in the absence of medical advice. At present, they represent many such medicines as have been evolved by the research departments of manufacturing concerns and embody among them ingredients some of which are very potent and poisonous. Accordingly, these are not at all suitable for self-medication and have no similarity to the so-called patent medicines. These products, instead of being advertised for direct medication to the laymen, are only advertised for the use of the medical profession, *e.g.*, 'Plasmoquine compound,' "Betaxin," etc.

The pharmacy laws in some of the advanced countries, as well, have fallen behind times. In one of the states of the United States of America, the term "proprietary medicine" is defined by the Pharmacy Act thus:—"Proprietary remedies, when not otherwise limited, mean remedies that a certain individual, or individuals, have exclusive right to manufacture or sell." Such definitions as these are very dangerous and help unscrupulous manufacturers to sell unstandard things under the name of proprietary remedies. Recently the Crescent Bottling Works, U. S. A., manufactured a solution of Citrate of Magnesia under the name of 'Duke's Magnesia citrotartrate' as a proprietary remedy, the difference between the official preparation and the proprietary remedy being that the latter was slightly adulterated and was understrength. Of course, the law courts prosecuted the firm for this evasion of the State laws but such things as the one mentioned here are going on in India unabated. The same conditions exist with aspirin compounds where aspirin, a purely chemical compound, is mixed with a little acetanilide, or phenacetin, or caffeine, etc., and given fancy names and sold as a proprietary remedy.

There are many other cases where medicines which are practically simple mixtures of official substances are sold as proprietary remedies. The formula, for instance, of "Kapseals Ventriculin with Iron and Vitamin B" is given as follows: (1) Ventriculin 5 grains; this is the proprietary name for Stomach, now official in the U. S. P.; (2) Naferon, 2 grains; this is Iron and Ammonium Citrate neutral; and (3) Vitamin B_1 and Vitamin B_2. Again, a firm is marketing a chemical compound, Ammonium Mandelate, under the fancy name Mandamon. It will thus appear that a great many proprietary remedies of to-day are simply prescription products but are sold as such, which helps them to get more money from the public. Instead of prescribing the proprietary medicines, it would be far better if the medical men wrote prescriptions and the Indian manufacturers manufactured galenicals and other products like yeast extract, stomach (U. S. P.), ammonium mandelate, phenobarbitone, etc., because such procedure would save a lot of money to the customers, who in a great many cases are asked to pay fancy prices for adulterated drugs, bottled in fancy bottles, and packed in cartons with attractive printing, in the name of proprietary remedies, the ingredients of many of which are unknown even to the prescribers.

Let us take a few more examples of the composition of proprietary remedies and compare them with official remedies which can be prepared and sold at a very cheap rate. Sprays and inhalants containing about 1% chlorobutol, ephedrine, camphor or menthol, thymol, oil of cinnamon, etc., dissolved in liquid paraffin are sold under proprietary names and charged huge prices whereas the same can be dispensed in any dispensing shop at less than half the cost. Further, the same preparations, if sold under names given in official books of various countries, can be obtained at a much cheaper rate than when purchased as proprietary and patent remedies. There are a large number of so-called proprietary preparations in the market containing glycerophosphates of calcium, potassium, sodium, magnesium, iron, manganese, strychnine, etc., with a little colouring matter, syrup, glycerine, and alcohol. Such preparations can be dispensed very cheaply and easily or may be supplied by any of the manufacturing houses at half the cost under official names as compared with the prices paid for similar preparations under fanciful names. The formulae of syrups and elixirs of glycerophosphates are given in many books, *viz.*, the Australian and New Zealand Pharmaceutical Formulary (A. P. F.), British Pharmaceutical Codex (B. P. C.), National Formulary (N. F.), etc. and if one were to compare the constitutents of these formulae with those of the proprietary ones, it will become evident that the official preparations and proprietary preparations are very much alike, and in many cases, the official ones are much superior to the patent ones. Further, the official preparations can be combined with a little yeast extract, and nucleic acid or lecithin, etc., to add other properties, and thus replace completely the foreign and indigenous proprietary remedies, many of which are worthless.

It would seem desirable that medical men do not prescribe patent or proprietary medicines, unless they be truly proprietary and could not be prepared on the counter, *e.g.,* Abidol (A, B, D, Vitamins), pure synthetic organic compounds, various glandular products, etc., because by writing their own prescriptions, the members of the medical profession will be helping the real pharmaceutical industry by giving impetus to manufacturers to prepare basic pharmaceutical compounds instead of marketing simple concoctions. Further, many of the so-called indigenous proprietary remedies are simply admixtures which can be done easily in a dispensing shop but are done on a large scale by manufacturers and sold at exorbitant rates.

What are the implications of this question? This question of discontinuance of prescribing proprietary remedies will demand on the one hand a greater practice in the art of writing prescriptions from the practising physicians and on the other hand, the training of pharmacists will have to be improved. Further, the opening of new pharmacies shall have to be controlled by the Provincial Boards of Pharmacy, which must be satisfied regarding the qualifications of the manager and the dispensing chemist before permission is granted to any person or persons to start a pharmacy. Over and above this, the provincial Governments shall have to immediately take up the question of instituting proper courses for training pharmacists and dispensing chemist. A friendly coordination between a well-trained pharmacist and a medical man can help the development of pharmaceutical industry on sound lines. The Government has also to make laws prohibiting advertisements appealing to the public to buy medicaments for self-medication. If these suggestions be implemented, the pharmaceutical industry in India will make rapid progress on sound lines. The manufacturers will then take up the manufacture of various synthetic drugs, vitamins, hormones, enzymes, etc. and their energy will not be dissipated in manufacturing mixtures and concoctions.

Alumina and Cements from Waste Slags

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In all iron and steel plants very large amounts of furnace slags are invariably thrown out. All of them contain large percentages of silica which may vary from 10 to 60%, alumina from 0 to 40%, lime from 5 to 45% and small amounts of other substances like MgO, FeO, Fe_2O_3, S, Mn, etc. Sometimes, the amounts of FeO and Fe_2O_3 may also be large. In various parts of the world numerous investigators have tried to utilize these slags for the manufacture of varied articles, *e.g.*, cements, road blocks, insulating roof tiles, etc. The present paper contains the results of work in this direction with a view to the utilization of slags produced in Indian factories. The major part of the work deals with a blast furnace slag rich in alumina, while some attempts at making cements have also been tried from two other slags which are poor in alumina but rich in iron.* A slag rich in alumina has been treated like a poor quality bauxite for the extraction of alumina as in the Bayer's Process or more on the lines of the Pederson Process in which the siliceous and ferruginous bauxite is first converted into the form of a slag and then treated with alkali solutions. In the present work the residual part of the slag after the extraction of alumina has been further used for the manufacture of a true Portland Cement instead of adding it as an adulterant to a cement which is the common practice adopted in many countries.

Analysis of the Slag:—

On analysis the slag gave the following composition:—

	Per cent.
SiO_2	25.46
Al_2O_3	31.10
Fe_2O_3	0.70
MnO	2.13
CaO	35.33
MgO	4.16
S	0.80
Total.	99.68

*Aluminous slag used for extraction of alumina is from the Indian Iron and Steel Co. Ltd., Burnpur. The two other ferruginous slags mentioned are from Messrs. Tata Iron & Steel Co. Ltd., Jamshedpur.

The slag was crushed, finely ground and graded into 3 samples.

No. 1. Through 60 I.M.M. Mesh and above 100 I.M.M. Mesh

No. 2. Through 100 I.M.M. Mesh and above 200 I.M.M. Mesh

No. 3. Below 200 I.M.M. Mesh.

In order to determine which of these three samples was most suitable for the extraction of Al_2O_3, weighed amounts of each were taken and digested for periods of half an hour with different concentrations of NaOH solution at a temperature of about 75°C. After the digestion the residual slag was removed by filtration and washing with cold water. In the filtrate alumina was estimated by the usual methods. In every case it was found that the extraction of alumina was maximum with sample No. 3, but that from No. 2 was also very nearly the same. Thus though sample No. 3 was the best the small difference in the results did not justify the extra amount of labour required in grinding the material to below 200 Mesh. For most of the subsequent experiments, therefore, a sample passing through 100 Mesh only was considered satisfactory.

The procedure followed in all the experiments was as detailed below:—

A weighed amount of the powdered slag was taken in a narrow necked conical flask and a definite volume of the NaOH solution added. This volume was so adjusted that the ratio between the weight of the

NaOH present in the caustic solution and the weight of alumina present in the slag taken was nearly a constant. The level was marked on the flask which was then placed on a hot plate and kept just short of boiling for a known length of time. During the heating, as the level of the liquid fell due to evaporation of water, it was again brought up to the mark by fresh additions. This process was repeated every 10 minutes and thus the solution was not allowed to change much in concentration. After the full period of heating the residue was filtered and washed free of NaOH with the minimum amount of water. In the filtrate alumina was estimated.

TABLE I

Sample below 200 Mesh: Time of treatment 2 hours.

	Strength of NaOH Percent. by Weight.	Alumina Extracted. Percent. of the Slag.	Alumina Extracted. Percent. of total Al_2O_3 present.
1.	15.5	6.3	20.3
2.	24.4	9.7	31.1
3.	31.1	25.01	80.5

TABLE II

Sample ground below 100 Mesh: Time of treatment 2 hours.

	Strength of NaOH Percent. of Weight.	Alumina Extracted. Percent. of Slag.	Alumina Extracted. Percent. of total Al_2O_3 present.
1.	25.0	9.4	30.2
2.	31.1	19.2	61.8
3.	40.0	24.0	77.2
4.	50.0	21.9	70.5

TABLE III

Sample ground below 100 Mesh: Strength of NaOH 25%.

	Time of treatment.	Alumina Extracted. Percent. of Slag.	Alumina Extracted. Percent. of total Al_2O_3 present.
1.	1 hour.	6.1	10.7
2.	2 hours.	11.9	38.3
3.	3 hours.	9.4	30.2
4.	6 hours.	10.8	34.8

Alumina extracted in Nos. I, II. and III was pure while that in No. IV was contaminated with traces of iron and manganese.

TABLE IV

Sample ground below 100 Mesh: Strength of NaOH 40%.

	Time of treatment.	Alumina Extracted. Percent. of Slag.	Alumina Extracted. Percent. of total Al_2O_3 present.
1.	1 hour.	21.2	68.0
2.	2 hours.	25.8	83.0
3.	4 hours.	25.9	83.3
4.	6 hours.	25.8	83.0

The alumina obtained in Nos. I and II was pure but that from Nos. III and IV was slightly contaminated with iron and manganese.

From the above tables it will be clear that the best extraction results are obtained with 40% NaOH, the time of treatment being from 1 to 2 hours. If a weaker solution is used the extraction is poor and if the time of treatment is increased contamination comes in. At the same time a solution stronger than 40% does not seem to give better results.

The composition of the residue after removing alumina was as follows:--

	Per cent.
SiO_2	34.1
Al_2O_3	7.8
Fe_2O_3	1.1
MnO	2.7
CaO	47.1
MgO	5.8
S	undetermined.
Total	98.6

From the analysis it can easily be concluded that if the CaO is increased by about 15% at the cost of the SiO_2 the composition immediately becomes very nearly that of Portland Cement. Consequently this residue was mixed with powdered limestone in various proportions to prepare a batch for making Portland Cement. In accordance with the general process employed for cement making this batch mixture was fired in a furnace. The firing was done in fireclay crucibles of about a pound capacity and at a temperature of about 1400°C. The period of firing was about 2 hours, sufficient to sinter the mass well. This sintered mass was then cooled, ground to pass 200 mesh and tried as a cement.

	I	II	III
Slag Residue	100	100	100
Limestone	80	100	120

All the three powders behaved as good cements but No. 3 was the best, its setting rate and hardness being almost that of a good Portland Cement. The cements on analysis gave the following compositions:—

SiO_2	25%	to	27%
Al_2O_3	5%	„	7%
CaO	62%	„	65%
MgO	2.5%	„	3.5%

Experiments were also tried by using this slag directly in combination with aluminous laterite containing about 58% Al_2O_3 and limestone in proportions such as

	I	II	III
Slag	100	100	100
Aluminous laterite	60	80	120
Limestone	60	80	100

to give aluminous cements.

The procedure followed for firing was as described before but in view of the very refractory nature of the batch, a slightly higher firing temperature namely 1450°C was used. The product obtained showed good cementing properties but the results obtained were not as encouraging as in the case of Portland Cement from the slag residue. Two other slags which were not highly aluminous but contained large percentages of iron oxide and silica were also tried in combination with limestone and bauxite, the resulting cements being rich in alumina as well as iron oxide. One of these slags contained even as much as nearly 25% FeO and Fe_2O_3 taken together and the cement obtained from this contained about 38% alumina ,11% Fe_2O_3 and 35% CaO. But in all cases the products obtained from these two slags were very poor in strength and had extremely slow setting rates.

In the Bayers process, most usually employed at present, bauxite is treated with NaOH solution of nearly the same strength as recommended above and the treatment is done in autoclaves under pressure and it lasts for about 8 hours. In the above, the treatment is for a much shorter period and at ordinary pressure. The high percentage of lime prevents the attack on Silica during treatment with NaOH. In the Bayers Process lime has to be intentionally added to prevent the silica using up a part of the alkali.

The subject of this paper forms the basis of an application for a patent by one of the authors.

Cotton in Roads

C. K. Everett in *construction* for January 1938 points out that cotton fabric reinforcement for bituminous surfaced highways is one of the most interesting as well as promising developments in highway engineering. Particularly in the light of this season's all time record cotton crop the South may benefit, as every mile of "cotton road" absorbs in fabric the equivalent of from 8 to 10 bales of cotton. The acceptance by highway engineers generally of the fabric reinforcing technique received its greatest impetus early in 1936. Since then nearly 600 miles of "cotton roads" have been built in more than twenty states and the principle has been adapted successfully to not only the reinforcefent of bituminous surfacing, but of irrigation, soil conservation, malaria control and other types of ditches. Cotton road technique brings to the bituminous surface treatment of gravel-sand, sand-clay top soil or other earth type roads the reinforcing principle employed in constructing main arterial highways. Laid directly over the prime coat and covered with another application of asphalt and crushed, stone, cotton fabric memberane supplies an almost indestructible bond and practically waterproof blanket between the road base and top surface. Essential characteristics are (1) a tensile strength of 25 pounds or more in both the warp and filling material (2) an openness of weave to permit a satisfactory bond between the prime and cover coats of tar and asphalt; and (3) a soft twisted yarn to absorb sufficient bitumen to insure the fabric's preservation in the ground.

Jour: Frank. Inst.

Research Notes

Mutual Inversion of the Stark Levels of six-co-ordinated and four-co-ordinated Co^{++}-ions in Crystals

The ions Ni^{++} and Co^{++} occupy adjacent places in the periodic table and both are in F—states [d^7 ^4F and d^8 ^3F respectively]. Still they exhibit a striking contrast in the anisotropies of their hydrated salts [Nickel 2–4%, cobalt 30%]. This differential behaviour has been very elegantly explained by Van Vleck (*Phys. Rev.*, *41*, 208, 1935) in the following manner: Paramagnetic ions are under the influence of strong electric fields arising from the surrounding atoms or ions. This electric field splits the normal state of the ion into several components just as in Stark Effect, separation depending upon the symmetry and strength of the crystalline field. For a given crystalline field, which is predominantly cubic in symmetry and which has a small rhombic component also, the Stark patterns are exactly similar except that they are mutually inverted. One extreme level in the pattern is a triplet and the other a singlet. So the magnetic anisotropy which is directly connected with the lowest level is necessarily greatly influenced by this inversion. For the hydrated Ni-salts (sulphates and selenates) lowest level is a singlet, while for cobalt it is a triplet and hence the difference in their magnetic behaviour.

Gorter (*Phys. Rev.*, *42*, 437, 1937) has shown that the type of the cubic field referred to above corresponds to an octahedral arrangement of six negative charges (of H_2O molecules) around the paramagnetic ion. If, on the other hand, the paramagnetic ion is surrounded by four negative charges at the corners of a tetrahedron or eight at the corners of a cube, the terms in the expression for the potential of the field, which refer to the cubic part, change sign. The dispositions of the Stark pattern, thus, become reverse of those obtained with octahedral symmetry. The result for Co^{++}-ion for tetrahedral arrangement will be that the singlet level will be the lowest and the crystal will show little anisotropy.

One may, thus, expect to get tetrahedral type of distribution in salts in which Co^{++}-ions have co-ordination number (in chemical language) 4 instead of the usual 6. Two double chlorides of Co with alkali metals are the solitary instances of this type. X-ray analysis of Cs_3CoCl_5 by Powell and Wells (*Jour. Chem. Soc.*, 359, 1935) shows that each cobaltous ion in the crystal is surrounded by four Cl-ions, forming a tetrahedron with Co^{++} at the centre, the fifth Cl-ion standing apart at a greater distance. Accordingly one should expect in these crystals the anisotropy to be small in marked contrast with sulphates and selenates. Krishnan and Mukerji have recently shown (*Phil. Trans.*, *237*, 135, 1938) that this is only 6% in $Cs_3[CoCl_5]$ and less than 5% in $Cs_2[CoCl_4]$. They also found the very significant result that the mean susceptibilities of the crystals are smaller than those of the 6 co-ordinated double sulphates and selenates, and are nearer to 'spin only value'—a result predicted from Van Vleck's theory.

The argument against this mutual inversion of Stark levels may be that (1) the $(CoCl_4)$ groups may have perfectly regular tetrahedral structure and the rhombic component of the field may be totally absent, but this is highly improbable. (2) The different $(CoCl_4)$ groups that are present in the unit cell may be oriented relative to one another in such a manner as to form isotropic combinations; the low mean susceptibility of these as obtained by Krishnan and Mukerji does not support this possibility.

—*S. C. Deb.*

Dissociation Energy of CN Molecule

The chief obstacle to any direct determination of the dissociation energy of CN molecule

lies in its chemical instability. Thus the method by observing absorption continua or that of electron impact could not be successfully applied in this case. Up till now this was known through calculation only, in an indirect way, utilizing the dissociation energy of CO in conjunction with other thermochemical data such as combustion and heat of dissociation of cyanogen (C_2N_2), etc. R. Schmid, L. Gerö, and J. Zemplén have recently shown that even for such unstable molecules dissociation limits may often be obtained with success by observing the perturbations found in the band spectrum given out by the molecules (*Proc. Phys. Soc.*, *50*, 283, 1938). The method consists of finding convergence limits of diatomic molecular states by means of perturbations caused by converging states on other states of the molecule.

The spectrum of CN consists of two band systems only, involving three different electronic states $X^2\Sigma$, $A^2\Pi$ and $B^2\Sigma$. The band system arising from the transition $A^2\Pi \rightarrow X^2\Sigma$ lies in the red and that from the $B^2\Sigma$ to $X^2\Sigma$ lies in the violet. It is established that the more important perturbations are caused by the $A^2\Pi$ state. Aided by the positions of the perturbations the investigators could advance up to the 30th vibrational set of the $^2\Pi$-state when they observed the original vibrational frequency, and that the rotational constant considerably decreased— a sign of closeness of the convergence limit.

By comparing the vibrational sets of the $X^2\Sigma$ and $A^2\Pi$ states, they showed that their convergence limit should lie very near together, and that of the $B^2\Sigma$ should be about 0.6 e. volts higher. If $X^2\Sigma$ ($v = o$, $j = o$) be called it 0 it is found that the convergence limit of $X^2\Sigma$ is 61000 ± 1000 cm^{-1}, that of the $A^2\Pi$ about 60500 ± 1000 cm^{-1} and that of $B^2\Sigma$ about 65500 ± 1000 cm^{-1}. On this basis the correlation between C + N and CN levels is found as: $X^2\Sigma_{(Conv.)} \rightarrow C(^1D) + N(^2D)$; $A^2\Pi_{(Conv.)} \rightarrow C(^3P) + N(^2P)$; and $B^2\Sigma_{(Conv.)} \rightarrow C(^5S) + N(^4S)$. Thus the dissociation energy of the CN molecule into $C(^5S)$ and $N(^4S)$ atoms comes to be 809 eV.

—*S. C. Deb*

Discovery of the Femur and Humerus of Sinanthropus Pekinensis

In *Nature*, April 2, 1938 Prof. Weidenreich has announced the discovery of two fragments of femora and a fragment of humerus of *Sinanthropus Pekinensis* from locality I at Choukoutien. Several fragments of an adult female skull have already been recovered and described from this site.

Both the two femur fragments are completely fossilized and burnt. The existence of a distinct pilaster and a well-developed two-lipped linea aspera demonstrates its actual human form. The total length of the more or less complete femur has been estimated to be 400 mm. Platymery is pronounced throughout the entire length of the femur and the very faint curvature at the lower end of the diaphysis and the narrowest transverse diameter at the lower end are the chief characteristics of the femur. The femur differs from the Neandarthal group by the stoutness and the narrowest transverse diameter at the middle of the shaft of the latter and other peculiarities. The *Sinanthropus* femur differs widely from those of the apes and specially from that of a gibbon also. This discovery has shed some new light on *Pithecanthropus*. The latter femur differs from the *Sinanthropus* one exactly by those features by which it differs from modern man, and Weidenreich is of opinion that the *Pithecanthropus* femur has no relationship with the skull cap; the femur is too strong and too long for so small a skull. The *Sinanthropus* has already attained an erect posture, and the height calculated from the femur approximates 5 feet for females and 5 feet 4½ inches for males. This hominid was a cannibal.

The humerus presents well developed muscular impressions, specially of the deltoid, pectoralis major and teres major and the edge-like characters of the border indicate that the limb was used in the same manner as in recent man. Both the femora and the humerus belong to the female sex.

Weidenreich's view that *Sinanthropus* closely approaches man thus receives an additional support from the above discoveries.

—*S. S. Sarkar*

University and Academy News

National Academy of Sciences, India

A meeting of the National Academy of Sciences, India, was held on 29th March, 1938. Prof. D. R. Bhattacharya, Vice President, was in the chair.

The following resolutions moved by Prof. M. N. Saha were unanimously passed:—

1. That the government is requested to appoint a committee consisting of eminent lawyers, scientific experts and representatives of industry to study the present electricity act and to recommend necessary legislation required to nationalize the generation and distribution of electricity with a view to make the supply of electrical power in these provinces cheap and abundant.

2. That the government is requested to select a body of graduates in physics and electrical and chemical engineering to study the methods of construction of Power Station and the organization of generation and distribution of electrical energy in foreign countries like England, Russia and Switzerland. It is desirable that the body should consists of an expert and experienced electrical engineer who will be in charge of a batch of a number of students to study different aspects of the question, *i.e.*, two for studying constructional details, one for studying the methods of distribution of electricity, one for studying the economics of production and distribution, and others to study industries which are absolutely dependent on cheap supply of electricty.

3. That the government is requested to appoint a permanent body called the "Power Survey and Research Institute" to study the natural sources of power existing within or in the neighbourhood of the province. The person in charge of the above body should be a competent electrical engineer with experience and knowledge of the different branches of science *viz.*, Physics, Fuel engineering, Hydro-electric engineering, which are required for such kind of survey work.

4. That the National Academy of Sciences, India, will be prepared to furnish details with reference to the resolutions mentioned above.

5. That the National Academy of Sciences, India, notes with regret that the Government of the United Provinces, while appointing an Electricity Committee, did not consider it necessary to ask this Academy to nominate a specialist to serve on the said Committee. Resolved further that the Government of the United Provinces be requested to consider the advisability of associating representative or representatives of this Academy with all those investigations in which scientists can make useful contributions.

It should be noted in this connection that at the time of the annual meeting of the National Academy of Sciences, India, a symposium on the problem of "Power Supply in the United Provinces" was organized on March 5, 1938. At the conclusion of the symposium Pandit Jawaharlal Nehru, who presided, said that "the expert scientist is not always a helpful person. He does not realize that things to be put before the Government must be definite and must be related to what is actually happening." In moving these resolutions Prof. M. N. Saha referred to the remarks of Pandit Nehru and said that by passing these resolutions the Academy would meet the criticism and also put some concrete proposals before the Government of the United Provinces, proposals which if given effect to would render power in India cheap and abundant, and thus lead to the development of industries on sound lines.

The following papers were read and discussed:—

J. Dayal On a new species of the genus Astiotrema Looss (1901) from the intestine of a fresh water fish, *Clarias batrachus*.

M. Abdussalam On the occurrence of Skrjabinema ovis (Skrjabin, 1915) in India.

M. A. H. Siddiqui—The Genito-Urinary system of the Indian ground squirrel (*Funambulus Palmarum*).

Satya Prakash and S. B. Dutt—Colour and chemical constitution of the organic and inorganic salts of Di-phenyl violuric acid.

V. L. Verma and S. B. Dutt -Condensation of di-phenyl thiobarbituric acid with aldehydes, quinones and nitroso compounds, Indigoid dyes derived from chrysoquinone.

Indian Chemical Society

An ordinary meeting of the Indian Chemical Society was held on Tuesday, March 22, 1938, at

5-30 p.m. in the Chemistry Lecture Theatre, University College of Science, Calcutta with Rev. Father J. Van Neste in the chair.

1. The following gentlemen were admitted as Fellows, their subscriptions having been received for the first time:—

(1) Mr S. S. Cowlagi, (Bombay); (2) Mr A. C. Rothenheim, (Bombay); (3) Prof. Md. Qudrat-i-khuda, (Calcutta).

2. The following gentlemen were elected as Fellows by ballot, Dr S. Ghosh and Dr A. C. Sircar acting as scrutators:—

(1) Sudhindra Nath Sen; (2) Samarendra Nath Mitra; (3) Arabinda Majumdar; (4) S. N. Mukherjee; (5) J. C. Das Gupta; (6) H. K. Acharya; (7) Syed Bashir Ali; (8) B. C. Mukherjee; (9) Dr A. E. Lomnitz; (10) Prof. N. L. Vidyarthi; (11) P. N. Bagchi; and (12) N. Datta.

3. Dr Umaprasanna Basu, D.Sc. delivered a lecture on "Mineral Elements in Nutrition." Dr B. C. Guha and others joined in the discussion.

Royal Asiatic Society of Bengal

An ordinary monthly meeting of the Royal Asiatic Society of Bengal was held on Monday, the 4th April, 1938, at 5-30 p.m.

The following candidates were balloted for as Ordinary Members:—

Mrs N. C. Sen (Mrs Mrinalini Sen), (Calcutta); James Anderson, (Calcutta); and Mrs R. Chaudhuri, (Calcutta).

The following paper was read:—

Siddheswar Varma—The Dialects of the Khaśāli Group.

The following exhibits were shown and commented upon:—

(1) S. L. Hora—Aerial vision in fishes.

(2) C. S. Fox—The Rangala Meteorite.

Botanical Society of Bengal

The Second Annual General Meeting of the Society was held on Wednesday, the 23rd February at 5 p.m. at the Botanical Laboratory, Calcutta University.

Prof. S. C. Mahalanobis, President of the Society, took the chair.

The Secretary presented the Annual report. The number of ordinary members increased from 65 last year to 77 at the present year.

The six Ordinary General Meetings were held in which papers were read by members and discussions held.

The Society is now considering the steps to be taken to start a journal.

On the occasion of the Silver Jubilee Session of the Indian Science Congress, the Society organised an exhibition and Conversazione and a lunch at the Grand Hotel to meet the foreign delegates and Indian Botanists from outside Bengal

The Society is organising a branch of the Society at Dacca.

The following were elected office-bearers:—

President—Prof. S. C. Mahalanobis.

Vice-Presidents—Prof. S. P. Agharkar; Mr S. N. Bal; Prof. S. C. Banerji; and Prof. S. R. Bose.

Treasurer—Mr G. P. Majumdar

Secretaries—Dr J. Sen Gupta; and Mr A. K. Ghosh.

Council Members—Prof. I. Banerji; Dr K. P. Biswas; Prof. H. K. Bhattacharyya; Prof. A. T. Das Gupta; Prof. H. K Datta; Dr S. Hedayetullah; Mr W. Meiklejohn ;Prof. S. P. Nag; and Dr S. R. Sen Gupta.

Society of Biological Chemists, India

In a meeting held at Bangalore on March 4. 1938, the following papers were read:—

(1) B. Sanjiva Rao and K. S. Subramaniam-Essential oil from *Hemidescus Indicus* (Indian

Sarsaparilla); (2) K. V. Giri and N. S. Doctor-- The use of Pyrophosphate in the determination of Vitamin C content of plant and animal tissues; (3) K. V. Giri--Spectrophotometric study of a new colorimetric method for Vitamin C; and (4) C. N. Acharya—Interference of soil in the estimation of cellulose.

A lecture was delivered on "Some Rare elements in nutrition" by Dr V. Subramanyan.

In a meeting held at Indore on March 14, 1938, the following papers were read:

(1) Y. D. Wad and L. N. Desai--Variation in seed composition of crop plants-- Part I. Influence of soil and climate; and (2) V. G. Panse--Application of statistics to biological experiments.

In the Bombay meeting of the Society held on March 17, 1938, the following papers were read:—

(1) B. B. Dikshit--the formation of acetyl choline by the tissues; and (2) V. N. Patwardhan and R. G. Chitre—The effect of hypervitaminosis D on calcium and phosphorus metabolism in the albino-rats.

Geological, Mining and Metallurgical Society of India

The third ordinary general meeting was held on March 3, 1938 at 5 15 p.m. in the Presidency College, Calcutta, with Mr D. N Wadia in the chair.

The following papers were contributed:—

(1) B. C. Roy--Economic Geology of Panchet Hills; (2) B. G. Deshpande--On the Geology of Vengurla Peta; (3) P. K. Chatterjee--On the Geology of Khurda and its neighbourhood; and (4) N. Jayaraman and K. R. Krishnaswami--On a new Titanium bearing mineral from Nellore.

Indian Mathematical Society

The tenth Conference of the Indian Mathematical Society which was held at Lucknow on March 15, 16, and 17, 1938, was opened by Pandit G. V. Pant, Premier of the United Provinces, Dr R. P. Paranjpye, Vice-Chancellor, Lucknow University, was the Chairman of the Reception Committee, and Dr R. Vaidyanathaswamy President of the Conference. In his address Dr Paranjpye emphasized the need for a detailed scheme of work in the history of mathematics in India and observed that as the Indian Mathematical Society was pre-eminently fitted to make authoritative investigations in this field, it should immediately start the work. Besides some 40 papers on various topics in mathematics which were read in the conference, an interesting symposium on the "Relative Merits of Einstein's and Sulaiman's Theories of Gravitation" was held. Three popular lectures were delivered: (1) "The Theories of Gravitation" by Sir S. M. Sulaiman; (2) "Stars and Galaxies by Prof. A. C. Banerji; and (3) "Properties of Numbers" by Prof. T. Vijayraghavan, who also gave a brief address on "Tauberian Theorems." A select committee was elected to report on the systemization of research on the history of mathematical development in India which will be submitted to the Committee of the Indian Mathematical Society. The conference which was a great success was attended by delegates from practically every part of India.

Book Review

SEMI-MICRO QUALITATIVE ANALYSIS, *by Carl. J. Engelder, Ph.D., Tobias H. Dunkelberger, B.S., University of Pittsburgh, and William J. Schiller, Ph.D., Mount Mercy College, Pittsburgh. Cloth; 6×9; pp. x+265. John Wiley & Sons., Inc., New York. Chapman & Hall, Limited, London., 1936. Price 14s. 6d.*

SEMI-MICRO QUALITATIVE ANALYSIS, *by Paul Arthur, Ph.D., Assistant Professor of Chemistry, and Otto M. Smith, Ph.D., Professor of Chemistry, Oklahoma Agricultural and Mechanical College. Cloth; 5½×8; pp. xi+198. McGraw Hill Publishing Company, Ltd., New York and London, 1938. Price $2.00.*

Micro-chemical methods of quantitative analysis have been highly refined during the last several decades and have yielded very valuable results in the hands of experienced research workers, but their use has been confined to very limited fields due to the fact that they require a high degree of manipulative skill and technique as well as vibrationless laboratories. Hence, the conventional macro methods are being used throughout the world for general laboratory work. However, during the last decade, some laboratories have been studying the possibility of using the 'drop-reaction' methods in the systematic teaching of qualitative analysis and have evolved out the semi-micro methods of analysis which occupy an intermediate position between the conventional macro technique and the highly specialized micro methods.

The semi-micro schemes of analysis discussed in the above two books are little different from the customary macro procedures; only the technique and a few of the reagents have been changed. Generally, organic reagents are used for purposes of confirmatory tests only after the separations have been made and the preliminary inorganic tests run for the ions. The advantages claimed for the semi-micro methods of analysis are:—(1) the operations are confined to drops, or, at most, to one or two mils of solution; (2) lower expense to the student; (3) increased accuracy; (4) greater skill and respect for cleanliness; (5) greater speed and sensitivity. The equipment required is very simple and can be assembled in any laboratory with the help of a glass-blower or can be purchased at a little cost with the exception of a hand centrifuge which can be purchased at about Rs 16/- each and can be used by two students.

The procedure advocated in the book by Engelder *et al* has been used in the Pharmaceutical laboratories of the Benares Hindu University with success. The course is offered to the first year students who join the Department of Pharmaceutics after passing their I.Sc. examination and it has been found that the time taken in analysing substances is about 70-80% of that required in the macro schemes. The technique is acquired without any difficulty in a few weeks and the cost to the department is a very small fraction of that required for the macro procedures. The breakage loss is also insignificant as compared with that of the macro schemes. The semi-micro methods are ideally suited to the Indian conditions and will mean a great saving to the institutions.

The *Semi-micro Qualitative Analysis* by Engelder, Dunkelberger and Schiller embodies both theory and practice of qualitative analysis. It is divided into four parts. The first part deals with fundamental principles of qualitative analysis and covers 92 pages. The phenomena of ionization, solubility product principle, oxidation-reduction reactions in terms of valence and electron transfer, reaction velocity, law of mass action and of chemical equilibrium, fractional precipitation and the theory of sulphide precipitation, hydrogen-ion concentration and buffer solutions, amphoterism, the distribution ratio, electro-chemical theory of oxidation reduction and the structure of compounds including the Werner theory of

valency and Chelate compounds are discussed adequately with special reference to qualitative analysis. The fundamental theory, reactions and separations of the macro scheme have not been sacrificed but have been shown due consideration. Part II deals with the reactions of the cations and covers 75 pages. The reactions of the cations of each of the five groups are clearly explained and equations given. A large number of supplementary tests are included and the pages are replete with references to the original literature. Part III deals with reactions of the anions and covers 38 pages. Besides the inorganic anions, oxalates, tartrates and acetates are included here. Chlorates, hypochlorites, and citrates are not mentioned. Part IV deals with the systematic semi-micro methods of analysis of solid mixtures and covers 29 pages. Treatment of samples containing organic matter is not adequately dealt with. Dry tube test is not mentioned though it gives valuable indications regarding the presence of certain constituents.

The usefulness of the book would have been increased if semi micro technique had been explained in a little detail giving illustrations of the various operations encountered in the analysis. Some explanatory notes on the analytical procedures in Part IV would have helped students in getting an integrated view of the theory of analysis. Problems on calculations of qualitative analysis should have been included to make the book self-sufficient.

The *Semi-micro Qualitative Analysis* by Paul and Smith is a short and concise book, quite adapted to the needs of B.Sc. students of Indian universities. It is not as exhaustive as the book mentioned above, but the semi micro technique is explained with illustrations of apparatus, some numerical problems and other questions are given, and Notes on analytical procedures form a valuable feature of the book. The theory of analysis covers only 55 pages but eight pages are devoted to modern theories of electrolytes and mention is made of the Hydronium ion, the Debye-Hückel theory and Co-precipitation phenomena. Chemical equations representing separations of anions are given at one place and those of cations are collected together at another place. Reactions of ions are not discussed fully and the organic acid radicals with the exception of acetates are not treated at all. Treatment of insoluble sulphides like those of Hg is not sufficiently clear.

In spite of the minor faults mentioned above, the first book is suitable for honours students and the second book for pass students of Indian universities.

—*M. L. S.*

THE DRAMA OF CHEMISTRY, *by Sidney J. French, Assistant Professor of Chemistry, Colgate University. The University Society, Inc., New York City, 1937. Cloth; 6×9½; pp. vii + 170. 112 figs. Chapman & Hall, Ltd., London. Price 4s. 6d.*

The Drama of Chemistry is the most recent volume of the University series, the purpose of which is ' to present, in an attractive form and in a concise, readable style, the truly amazing story of the life of mankind – an authoritative survey of the physical and social sciences, history, philosophy, literature and the arts.' These books are not intended to be textbooks, and confusing details are avoided. The present volume is the fascinating story of chemistry starting from the prehistoric period and covering even the modern revisions of the dissociation theory, polar molecules, synthesis of vitamins and hormones, in an easy and understandable style.

The book is divided in ten chapters as follows:- (1) Early History; (2) The awakening of Chemistry; (3) The chemical Revolution; (4) The Era of Empiricism (5) The Theory of ions; (6) Structure of Atoms and Molecules; (7) Organic and Biological Chemistry; (8) Chemistry and Civilization; (9) The Chemist and his Work; and (10) The Future of Chemistry. There are suggestions for further reading, a glossary of some of the terms, and an index. The book is replete with illustrations and figures of most of the older and the modern chemists and physicists. This makes the volume vivid and living. Every student of science should read this volume, which is a moving drama rising from climax to climax as it sweeps along with increasing tempo and throughout this drama, there runs a constant refrain, the atom. The book is intelligent and stimulating.

—*M. L. S.*

Letters to the Editor

[The Editor is not responsible for the views expressed in the Letters]

On the Resistivity of thin Films of Metal

The well-known phenomenon of the increase of resistivity of metals as test-samples, when they are made into thin films, has been explained on the assumption that by reason of the extreme nearness of the bounding surfaces to one another, the f equency of collisions of the electrons with the walls greatly increases, and as such, the effective value of mean free path ($m.f.p - \lambda$) is very much diminished as compared with its value in bulk-metal. With this suggestion originally made by Sir J. J. Thomson, and under the assumption that collisions at the bounding walls are inelastic, *i.e.*, the angle of emergence after collision is quite independent of the angle of incidence, Lovell[1] has calculated the effective $m.f.p$ for films whose thickness is a small fraction of the $m.f.p$ in bulk-metal, the expression obtained being $\lambda' = t(1 + \log \lambda/t)$... (1) where t is the thickness of the film. In his derivation, the electrons are supposed to suffer collisions with the bounding walls only, and not inside the body of the metal. Retaining the assumption of inelastic collisions at the boundary, a still more accurate expression can be derived by taking collisions inside the body into account as follows:

Choosing any point on either boundary as origin, if we consider the direction θ, where θ is the angle the direction in question makes with t (for figure vide Ref. 1, *loc. cit.* page 325) the maximum separation of the boundaries along θ is $t/\cos\theta$. Introducing now from the kinetic theory of gases the well-known results of distribution of free paths, we can see that of the electrons starting from any point, say the origin, between θ and $\theta + d\theta$ (the number of which is proportional to $\text{Sin}\,\theta d\theta$), the number of electrons with free paths between 0 and x ($x = t/\cos\theta$) is proportional to

$$\int_0^x \frac{1}{\lambda} e^{-x/\lambda} dx \quad ,$$

and the number of electrons with free paths exceeding x

$$\text{is} \quad \int_x^a \frac{1}{\lambda} e^{-x/\lambda} dx.$$

Then observing that for the last group of electrons, the free path is $t/\cos\theta$ only, the effective mean free path is

$$\lambda' = \int_0^{\pi/2} \text{Sin}\,\theta\, d\theta \left(\int_0^x \frac{1}{\lambda} e^{-\frac{x}{\lambda}} dx \cdot x \right)$$

$$+ \int_0^{\pi/2} \text{Sin}\,\theta d\theta \left(\int_x^\infty \frac{1}{\lambda} e^{-\frac{x}{\lambda}} dx \right) x \qquad \ldots (2)$$

where after the integrations within the parenthesis having been performed, the integration with respect to θ is completed with x being put equal to $t/\cos\theta$, and we obtain

$$\lambda' = \lambda\left[1 - \int_0^1 e^{-t/\lambda x} dx\right] = \lambda\left[1 - f\left(\frac{t}{\lambda}\right)\right] \ldots (3)$$

The expression (3) is not only more accurate for films thin in comparison with λ, but it will also be valid for any thickness. For it may be supposed that the final electronic density in the metal is brought about by shooting the electrons one by one in a perfectly random manner through the boundary towards the interior of the metal. It can be seen that for

$t = 0$, $\lambda' = 0$ and for $t = \infty$, $\lambda' = \lambda$ so that if ϱ_∞ is the resistivity for bulk-metals and ϱ_t that for a sample of thickness t we must have, since ϱ varies inversely as λ,

$$\varrho_t = \frac{\varrho_\infty}{1 - f\left(\frac{t}{\lambda}\right)} \qquad \ldots (4)$$

It is clear that given λ and ϱ_∞, resistivity for any thickness can be calculated or given ϱ_t and ϱ_∞ can be deduced. Knowing λ, again it is possible to make an estimate of free electron density in metals.

In the following table, a comparison of Lovell's experimental data for Rb with those computed from (4) is presented. The value of λ has been calculated from Drude formula as modified by Fermi-distribution, on the assumption that number of electrons (n) per atom is one.

LETTERS TO THE EDITOR

$T=70°k$, $\lambda=2580A$.

t in A	90	80	70	60	50	40	35	30	∞
$\varrho_t \times 10^6$ (experimental)	11.9	13.0	15.0	19.0	22.9	28	38	1.97	1.97
$\varrho_t \times 10^6$ Theoretical	14,81	16.15	17.91	20.1	23.17	27.36	30.27	33.96	..

It would be seen that experimental values are systematically too low except at and above $t=30\mathring{A}$ in which region the films being unstable, a formula derived under the above conditions may not hold. It is interesting to note however that a choice of λ is possible which ensures very close agreement over the entire range from $t=30\mathring{A}$ to $t=\infty$. Such a value of λ is 1900A. If however this value of λ is substituted in modified Drude formula, e. g., $P=k/N^{2/3}\lambda$ (k is expressible in terms of e and h) the number of free eletcrons for Rb exceeds one per atom; but there is evidence[2] from other quarters to show that free electron density is rather smaller than, far from exceeding, one per atom. It would seem therefore that either the above values of ϱ and t are a little too low or the theory requires further modification.

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1. A. C. B. Lovell, *Proc. Roy. Soc.* A. 157, p. 311.
2. "Refractive index af thin films of Potassium", B. Mukhopadhaya, *Current Science*, July 1934, *3*. Also C, Zener's (*Nature, 132*, 968, 1933) explanation of the transparency of alkali metals above certain critical frequency requires for closer agreement with Wood's experimental values that n be less than one per atom.

A Note on the Possibility of Titration of Daboa and Cobra Antivenene in vitro

Lamb[1] was the first to attempt the titration of (Cobra) antivenene by precipitation reaction. He came to the conclusion that there was no relation between the potency determined by animal experiment with that determined by precipitation reaction. His results were however contradicted by Calmette and Massol,[2] who recorded that it was possible to determine the potency of antivenene by precipitation reaction.

Recently Mallick[3] tried to determine the potency of the Kasauli antivenene by flocculation test and failed to confirm the results of Calmette and Massol. We also studied the flocculation reaction of antivenene against different protein fractions separated from cobra venom, and found that the flocculation reaction occurs with a protein fraction which does not contain the cobra neurotoxin. Therefore Mallick's and our results are in agreement with the observation of Lamb that the precipitation reaction cannot be used for the *in vitro* titration of antivenene against cobra venom.

We next tried to tritrate the potency of the Daboa antivenene by flocculation test. The results which we have so far obtained appear to be fairly satisfactory. Of a series of tubes containing Daboa venom and antivenene in different proportions, the one containing the balanced mixture was found to develop a greater turbidity than the others. The results obtained from four different samples of antivenene, very kindly supplied to us by Col. J. Taylor, Director, Central Research Institute, Kasauli, are recorded in table 1. It will be noticed that the potency determined by the turbidity measurements agrees well with that determined by animal experiments. Further work is in progress.

TABLE I.

Number of the antivenene sample.	Potency determined. By animal experiments. * units per c. c.	By turbidity test. * units per c. c.
1	180	175
2	320	300
3	318	285
4 (Concentrated)	680	667

* One unit is equivalent to one m. l. d.

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1 Lamb, *Brit. Med. Jour.*, April, 2, 917, 1904.
2 Calmette and Massol, *Ann. de l'Inst. Past.*, *23*, 155-165, 1909.
3 Mallick, *Ind. Jour. Med. Res.*, *23*, 525, 1935.

Vitamins B_1- and B_2-Content of the Molasses

The molasses has recently drawn our attention for its mineral content, useful in human nutrition. In the present paper an attempt has been made to find its vitamins B_1 and B_2 content according to the biological method of assay with young rats as modified by Guha and Chakravorty.[1]

LETTERS TO THE EDITOR

(1) Two lots of date-palm molasses (S. G. 1. 3) procured from the local market were fed to young vitamin-B_1 and B_2 - deficient albino rats respectively in 2 g. doses for a period of three weeks and the average weekly gain in weight was determined. From these data the corresponding units, as defined by Guha and Chakarvarty[2], per 100 g. of the stuffs were ascertained. The results are given below:

	Units of vitamin B_1	Units of vitamin B_2
Molasses (a)	21.6	16.0
Molasses (b)	24.3	17.3

(2) A sample of sugarcane molasses and another sample of *Khejur Patali* or solidified datepalm molasses, in doses of 4 g. when similarly tested, furnished the following results :-

Per 100 g. of the stuff	Units of B_1	Units of B_2
Cane Molasses	10.4	2.7
Khejur Patali	8.75	6.45

To avoid any chance of fermentation the samples under investigation were preserved in the refrigerator during the test period. It must be mentioned here that the sample of *patali* was a genuine one prepared from fresh juice in a remote village (Gopinathpur, Kushtia) and not the adulterated kind available in the Calcutta market.

From the above results it is clear that the palm molasses is a good source of the vitamins B_1 and B_2 and that in all kinds of *gurs* the vitamin B_1 preponderates over the vitamin B_2. The unusually low vitamin values of the *patali* may be accounted for by its method of preparation. In our rural areas the first-class *patali*, as one here tested, is made from the 'sanjo ras' or the fresh juice obtained by tapping the dried-up surface of the peeled portion of the date-palm tree after a reasonable interval from the previous tappings. As the cold winter night juice is preferred for such a preparation, this process naturally minimizes fermentation. The molasses, on the other hand, is generally prepared from the juice of the subsequent tappings where noticeable fermentation takes place. The presence of a considerable amount of vitamin B_1 and B_2 in the fermented date-palm juice has already been observed by Guha and Biswas[3].

I wish to express my sincere thanks to the authorities of the firm and also to Mr M. Ray for his careful supervision of the test animals all through the experimental period.

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Bengal Chemical & Pharmaceutical Works, Ltd.,
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1. *Ind. J. Med. Res.* *20*, 1045.
2. *Ibid* *21*, 211.
3. *Ind. Med. Gaz.* *52*, 382.

Natural Gases in Sylhet

In Sylhet (Assam) there is a constant emission of natural gases over a few acres of land in the midst of small hillocks, at a distance of some fourteen miles from the town of Sylhet, along Sylhet-Shillong Road. We visited the place and collected a few samples of the gas from different parts of the field. This has been analysed both chemically and spectroscopically. The spectroscopic investigations have been caarried out in collaboration with Profs. D. L. Das and P. K. Raha. The results of analysis of three samples are as follows :—

		Mean
Carbon dioxide	..	0
Oxygen	..	0.78 %
Carbon monoxide	..	0
Olefines, Acetylenes and Benzene	..	0
Nitric oxide	..	0
Hydrogen	..	0
Methane	..	59.68 %
Ethane	..	18.55 %
Nitrogen	..	21.40 %
Helium and other rare gases	..	0
	Total	100.41 %

Density of the gas = 10.70 (with reference to hydrogen as unity). Our thanks are due to Prof. J. M. Dutta, for giving us facilities for work.

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Need for Nutrition Advisory Board in India

INTEREST in the problem of nutrition, to which the upheaval of the tragic years of the Great War first drew attention, has been continually on the increase in all civilized countries. It has been gradually realized that in spite of the progress made in medicine and hygiene, in spite of the knowledge of the infective nature of many maladies which indicated the measures to be adopted for stamping out epidemic disease, and in spite of the increasing popularity of physical training for fortifying the body, the physical condition of a large part of the human race is still far below the accepted standard. It has been established that this inferiority in physical condition as well as a large amount of preventible human suffering and disease is largely due to imperfect nutrition. The importance and urgency of the problem led the British Medical Association in 1933, the League of Nations in 1935 and 1936 and the International Labour Office in 1936 to appoint expert committees to report on the optimum dietary standards and on the state of nutrition of the people in European countries. The report of the Committee of the League of Nations, issued in four volumes, is thorough and comprehensive, but it is greatly to be regretted that although India is a member of the League of Nations and contributes liberally for its maintenance every year, no mention is made about the state of nutrition and about the production, consumption and prices of food stuffs in India. Nor has the League undertaken any dietary surveys in India as it has done in the countries of Europe.

The problem of nutrition is by no means identical in all countries. There are considerable differences between different nations- and in India even between the different provinces both in the degree and nature of malnutrition and in the extent to which the national and provincial resources would allow of improvements. In every country, therefore, there is a problem to be solved, a defect to be corrected.

Nowhere is the problem so acute as in India. A mere look at the Indian masses is sufficient to convince one that the vast majority of them are ill-nourished and suffer from the consequences of defective nutrition. The high rate of infant mortality and of mortality at the time of child-birth, the excessive proportion of under developed children and adolescents, a large number of cases of blindness in children and the poor health of a large number of people are the results of inadequate nutrition. Beri-beri, osteomalacia and scurvy are known to be of nutritional origin. Economic considerations undoubtedly play an important role, and inadequate family resources are the greatest single cause of defective nutrition. Even without effecting any changes in the level of national income, however, some measure of improvement in

the standard of nutrition may be attained. This is possible by the elaboration of cheap balanced diets for Indians which is only practicable after the different Indian foodstuffs have been analysed, by better organization of supplies, by disseminating knowledge as to the principles of rational nutrition and by pointing out the deficiencies in the ordinary diets and suggesting supplements.

We therefore draw the attention of the public and the Government to the thoughtful article on the problems of nutrition by Dr. K. P. Basu which we publish elsewhere. The constructive suggestions regarding the formation at an early date of Nutrition Advisory Boards in the provinces working in cooperation with a Nutritional Advisory Committee for all India should be immediately given effect to. These Boards should not only have a competent personnel, but should have adequate funds at their disposal to carry out nutritional surveys, define satisfactory and practicable dietary standards for each province and undertake propaganda through trained workers.

The problem of nutrition in India is a very complex one but its importance is fundamental. It will not do simply to emphasize that nothing of permanent value in this direction can be done in a country where in spite of acute poverty, accretions of thirty millions to the population take place in a decade. The problem of population can be tackled with greater zest if the masses could once be brought up to a more satisfactory standard of living. It is to be hoped that the popular ministries in the provinces will not be appalled by the magnitude of the task but take up this vital question of nutrition in right earnest at the earliest moment.

Hormone Causes Rat to Cherish Squab

The spectacle of a healthy, grown-up female rat cherishing and mothering a tender young squab, just because a few drops of a hormone from the pituitary gland had been injected into the rat's body, was described by Prof. Charles R. Stockard of Cornell University Medical College at a meeting of the New York Academy of Medicine.

Prof. Stockard used this phenomenon to illustrate the powerful influence that hormones or gland secretions may exert on the body of man and other animals. The rat in question was a normal animal that ordinarily would have made a prompt meal of the tender squab. The only difference in this particular rat was the few drops of hormone.

Hormones have other effects on the body. Together with the nervous system and brain they are responsible for all the different parts and mechanisms of the body working together as a whole. Hormones and nerves, moreover, depend on each other. Nerves stimulate glands to secrete hormones and hormones stimulate nerves to control muscles, even in such simple movements as those involved in walking and talking. Which of the two is more important may be surmised from the fact that hormone control is an older and more primitive method of integration than the nervous mechanism. Plants, for example, do not have anything like nerves, but they do produce hormones.

—Science Digest

The Problem of Nutrition in India

K. P. Basu

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DURING the last thirty years, scientific research in the field of nutrition has led to finding of great significance. There is now essential agreement regarding the composition of a rational diet and the dietary needs of the different age-groups. It is fully recognized that all nutrition schemes begin with the expectant and the nursing mother and that only by adequate nutrition in the earliest years of life can the health and the full development of the future citizen be assured. Although the dietary needs of the grown-up should also receive attention, from the nutritional standpoint they are to be looked upon more or less as "damaged goods."

Foods have been divided into (*i*) energy-bearing foods, such as cereals, fats, and sugar, (*ii*) body building, protein-rich foods, such as meat, fish, eggs, milk and pulses, and (*iii*) protective foods rich in vitamins and minerals, elements which are necessary to prevent the incidence of specific maladies, and which are present in milk and dairy products, fresh fruits and vegetables, and in eggs. While instinct and dictates of appetite adjust the intake of food to the heat requirements with extraordinary accuracy, they are no guide for body building and body-protection purposes. Hence in tackling the provision of a suitable diet, one should begin with the protective foods, then proceed to the body-building foods and then leave the energy-bearing foods to the dictates of appetite. Of all the protective and body-building foods milk is regarded as of outstanding importance, since it contains most or all of the materials necessary for growth and maintenance of life, such as proteins, minerals and vitamins, in a form easy of absorption.

A few words regarding the need of the different food constituents may not be out of place.

Vitamins

The vitamins of which about twelve have been differentiated direct by their presence in minute amounts the correct utilization of the other dietary elements. Many diseases, *e.g.*, beri beri, rickets, scurvy, ophthalmia, dental caries, osteomalacia, pellagra, are known to be caused by the absence of one or more of the vitamins. Investigations on the isolation in the crystalline condition and synthesis of vitamins are being pursued with great zeal, and in 1936 Williams achieved the distinction of synthesizing the anti-beri-beri vitamin B_1. Evans has obtained the anti sterility vitamin E in a pure form from rice germ oil. Szent Györgyi claims the isolation of a new water-soluble vitamin P, which appears to be a vegetable dye, or dye of the group of flavones, and which by its absence causes increased permeability or fragility of the capillary wall. The existence of a new fat-soluable vitamin K whose deficiency is characterized by hæmorrhages and by anæmia in chicks, ducks and geese is claimed by Dam and Schonheyder. The vitamin B complex consists of at least six factors, two heat-labile and four heat stable.

In India attention should be paid to the adequate provision of vitamins B_1, A and C in the diets. Due to the abundance of sunlight the provision of vitamin D is not such a pressing problem in India as in England and other European countries, where rickets was until recently common among children. Even in India provision of vitamin D in the form of cod-liver oil or some other form is necessary in the case of expectant and nursing mothers. For prevention of beri beri under-milled or *dhenki*-husked rice and whole wheat (*âtâ*) should be taken. The question of regulating by law the degree to which rice should be milled for home consumption should not be lightly brushed aside. Other good sources of the

anti-beri-beri vitamin are egg-yolk, pulses, yeast or yeast extracts, liver and kidney. Par-boiled rice contains more vitamin B_1 than the sun-dried variety. Discovery of a cheap source of the fat-soluble vitamin A whose deficiency is responsible for thousands of cases of blindness in children and night-blindness in adults in our country is an urgent problem. The liver and the body oils of the different varieties of Indian fish should be examined for their vitamin A and D content. Our investigations show that Ruhee liver oil is a good source of vitamin A while Ruhee body oil and Hilsa liver oil are not such potent sources of this vitamin. The Hilsha body oil does not contain any vitamin A at all. Dr Guha has recently determined the vitamin A content of different fish oils. Some of these oils might prove to be as potent sources of vitamins A and D as the cod-liver oil. Green vegetables and carrots contain carotene which is transformed into vitamin A in the body and should therefore be consumed daily. Cows which get little green grass give milk which contains less vitamin A than the milk obtained from cows fed on succulent green grass. Butter is a good source of vitamin A, while *ghee* contains little or none of this vitamin. Red palm oil is rich in carotene and vitamin A and attempts should be made to grow this tree in India. Fresh fruits specially the citrus varieties are rich sources of vitamin C and should be taken regularly. Fresh vegetables also contain a good amount but this is largely destroyed during the process of cooking. Oranges, lemons, mangoes grow abundantly in India and all classes of people should be advised to take them. Vitamin C is used up in combating and neutralizing the toxins of infectious diseases, and oranges should be taken liberally during an attack of fever and infectious diseases. Deficiency of this vitamin causes scurvy, the first observable symptoms of which include "laziness, gloom and irritability, showing itself in a tendency to condemnatory and uncalled-for argumentativeness"—symptoms which are by no means rare in India.

Minerals

Recent researches have revealed the great importance of an adequate amount and a correct balance of minerals in the diet. Of these calcium, phosphorus and iron are of special interest. Bone and teeth are largely composed of calcium phosphate, and a smaller but necessary supply of iron is required for the formation of red blood corpuscles and prevention of anaemia. Traces of copper and manganese help the assimilation of iron. A minute provision of iodine is necessary for the prevention of goitre. Milk is rich in assimilable calcium and phosphorus and vegetables and fruits are also good sources of mineral elements. While cereals, fish and meat are acid-formers containing an excess of the acid-forming minerals, milk, fruits and vegetables are base-formers and their consumption helps the elimination of uric acid, an accumulation of which causes gout.

Rice is poor in calcium, while wheat contains a fairly large amount. Our experiments on the human subject show that rice calcium as opposed to wheat-calcium is poorly absorbed by the body. A portion of the rice of the rice-eaters' diet should be replaced by wheat. The deficiency of calcium in the rice-eater's diet has also been recently pointed out by Dr Aykroyd of the Coonoor Laboratories.

There is plausible evidence of calcium deficiency in a large portion of the populace both ante natally and post-natally till the time of cessation of growth. A deficiency of calcium in the diet is to be expected in pregnant and lactating women unless special precautions are taken. Iron, too, is frequently deficient in the diet of such women. There is evidence that the haemoglobin figure of the blood can be raised in apparently normal women to a figure as high as the average men's by iron; and it is possible that the lower figure accepted as normal for women is simply the result of the recurring loss at menstruation, not corrected by adequate consumption of iron.

The League of Nations' suggestions with regard to mineral intake have been accepted in many quarters. For calcium 0.6 gms per day for the adult male and female; 1.2- -1.6 gms for children and adolescents; 1.6 gms for expectant and nursing mothers. For phosphorus the intake should be a little more. For iron probably 10 mgms available iron is satisfactory, though pre-

nant and lactating women might with advantage have 15 mgms.

Proteins

Proteins supply building material for the body and also repair the waste of tissues. Protein-rich foods are fish, meat, eggs, milk and pulses. The cereals contain a fair amount, rice containing the least. As a rule proteins from animal sources like milk, eggs, fish and meat are better utilized by the body than vegetable proteins which have lower biological values. During growth, pregnancy and lactation, some high-class protein is essential and in the growing period it should form a large proportion of the total protein. Nutritive value of the proteins of Indian foodstuffs is the subject of intensive investigation in our laboratories. Rice, though poor in proteins, appears to contain first-class protein, 80% of which is retained in the body and for purposes of growth *aman* rice is immensely superior to *aus*. Fifty to sixty per cent of the pulse proteins are generally retained by the organism, the value being only 32% in the case of lentil. For purposes of growth lentil and *khesari* proteins by themselves are of little value. Our investigations also show that supplemented with milk, fish, *aman* rice and egg proteins, the pulse proteins are better utilized and act more efficiently in promoting growth. Pulses are the chief source of proteins of vegetarians in India and should always be supplemented with milk in their case. The above allowances of total proteins are recommended by the League of Nations Committee, a part of the protein being of animal origin (or high class)

Age (years).	Grammes per kilogramme of body weight.
1 - 3	3.5
3 - 5	3.0
5 - 12	2.5
12—15	2.5
15—17	2.0
17 - 21	1.5
21 and upwards	1.0
Women—pregnant-	
0— 3 months	1.0
4 - 9 months	1.5
Nursing	2.0
	(1 kgm.= 1000 gms. =87.5 tolas=2.2 lbs.)

Our experiments on the human subject show that protein requirement in Indian climate is much less than that in temperate countries. But it is always better to exceed the bare requirement of protein during the period of growth. In old age, specially if the liver and the kidney are not functioning properly, excess of protein should be avoided.

Fat Requirements

Fat must be a constituent of the normal diet. About 40-60 grammes of fat should be consumed daily. In the absence of fats carotene from green vegetables is not well absorbed. The high content of vitamins A and/or D in certain fats justifies their use in liberal amounts.

Calorie (Energy) Requirements

The living body derives its energy mostly by the oxidation of carbohydrates and fats. One gramme of carbohydrate yields about 4.1 calories and one gramme of fat about 9.45 calories. Proteins also can be utilized for this purpose and one gramme of protein produces about 4.1 calories. The League of Nations Committee considers an allowance of 2,400 calories per day as adequate to meet the requirements of an adult living an ordinary everyday life in a temperate climate and not engaged in manual work. The following supplements for muscular activity are recommended to the basic requirements:

Light work	up to 75	calories per hour of work.	
Moderate work	„ 75-150	„	„
Hard work	„ 150-300	„	„
Very hard work	„ 300	„ and upwards per hour of work.	

Energy requirements for other ages and for mothers are also indicated in the report. There are reasons to believe that basic calorie requirement in a warm country like India is lower than that in temperate countries. About 10-15 p. c. of the daily calories should be derived from proteins, about 60 p. c. from carbohydrates and the remainder from fats.

THE PROBLEM OF NUTRITION IN INDIA

Special Dietary Needs of Different Classes and Age-Group

Viewing the nutrition question as a whole, the greatest emphasis deserves to be laid on the nutrition of children, pregnant women, and nursing mothers. There is a greater need for good nutritional material during the period of growth than for a fully grown person. Imperfect nutrition in the period of rapid growth causes tissues and organs to be badly constructed. Some of these defects are not only serious but irreparable even if followed by adequate feeding. Individuals very often bear the stigma of defective feeding in childhood throughout their lives.

Feeding of Pregnant Women and Nursing Mothers

All nutrition schemes begin with the expectant mother. Proper development of the fœtus is impossible unless the mother is adequately nourished. It is faulty maternal nutrition which may delay the subsequent full growth of the child and render it a weakly infant, troublesome to feed, difficult to rear, and subject to illness. The expectant and the nursing mother needs extra nutriment because of the large amount of material which she has to pass on to the offspring before birth or in her milk. Between the twenty-eighth week of pregnancy and full term the maternal organism has to supply to the fœtus as much as 25 gms. of calcium and 15 gms. of phosphorus and a nursing mother provides .4 gm. of calcium daily to her infant. The mother needs plenty of cow's milk—about a seer a day—to provide the extra calcium and phosphates which are taken away from her in this way. Some of the distressing complaints during pregnancy, such as muscle soreness and weakness and consequent inability to perform ordinary daily activities and also inability to sit or lie long in one position, are related to the defective calcium nutrition, and relief follows the administration of additional calcium and vitamin D. Fresh fruits and vegetables and some cod-liver oil should also be supplied daily to the mother to provide for vitamins C and D—as also one egg and some (about 120 grammes) fish or meat. If the expectant mother is ensured a plentiful supply of calcium, iron and vitamins A, D and E, there is every justification to anticipate a healthy pregnancy resulting in the birth of a full-time child who develops steadily, teethes normally, sleeps contentedly, and grows robustly.

Feeding of Infants and Growing Children

Complete breast-feeding of infants during the first 8-9 months of life is always to be recommended. It is cheaper, simpler and cleaner than artificial feeding, and in the case of a properly fed mother, the benefits to the infant are great. Data about 20,061 infants during the first nine months of infant life collected by an Infant Welfare Centre show that of the 9,749 wholly breast fed infants, total deaths were 15, of which four died from respiratory infections, of the 8,605 partially breast-fed babies 59 died, and of the 1,707 artificially fed babies 144 died, of which 82 died from respiratory infections. The infant even when breast fed should receive daily supplements of (1) orange juice to provide the anti-scorbutic vitamin C and (2) whenever abundant sunshine is not available (specially in European countries), a small daily ration of cod-liver oil of good quality, increasing gradually to 6 grammes daily to provide vitamin D. For breast fed infants in India, who are exposed to much sunshine, the need for extra vitamin D is not very great. Artificially fed and premature infants have even greater need for supplements than normal infants. The infant's reserve of iron is usually exhausted before the sixth month and milk is deficient in iron. Addition to the diet of infants of small amounts of foods rich in iron is recommended from the fourth or the fifth month. Foods recommended are egg yolk, if tolerated by the infant, or *purées* of green vegetables or carrots; in special cases direct administration of iron salts may be ordered by the nutritionist.

As regards growing children, Professor Mottram states, "Make sure of the body-protecting and body-building foods, and leave appetite to determine the calories." Of course, with the greedy child some attention is to be paid to a possible risk of ketosis. It is definitely established that many of the ill effects which result from deficient diet in childhood are avoidable by adequate provision of milk. The Committee of the League of Nations recommends daily intake of

750 gms. (about ¾ seer) of milk for children aged 1-2 years and of 1,000 gms. (about a seer) for children aged 2-14 years. Daily intake of an egg, some green leafy vegetables, potato, cod-liver oil and fresh fruits is also advocated. Meat or fish is advocated from the fifth year.

Nutrition and Agriculture

The "optimum" dietary has been expressed as a scientific formula. The general rules of nutrition have got to be translated into national and local dietaries. It has got to be considered to what extent the requirements would be met by national agriculture, and to what extent by importation, if necessary.

So far as India is concerned the official figures as they stand show that the acreage under food crops, unlike that under cash crops, has not kept pace with the growth of population; on the contrary, there is an actual decrease in the acreage per head. The non-food crops, on the other hand, have kept pace with the population.

It has been made quite clear that if there is to be the necessary physical strength and health, it is essential that all classes of the population and primarily children and young people should be able to consume regularly certain quantities of "protective foods," such as fresh milk, vegetables, fruits, eggs, and fish. Fresh milk and fresh vegetables are nearly always produced and sold on the spot or within a comparatively limited area and the same may be said of many fruits and of a great deal of dairy products, eggs and fresh fish. It follows that an increased demand for such produce would have to be met in the main by the output of local agriculture. It is, therefore, essential to increase the yield of staple crops (cereals) per acre in India so as to liberate the land for the cultivation of these supplementary foods and of fodder for cattle. This should be quite feasible in India when scientific methods have scarcely begun to be introduced in agriculture. Increased knowledge of the nature of the soils can make fertilization more effective and the most spectacular advance has been and is being made through the work of the plant-breeder. The elaboration of the improved varieties of sugar-canes at Coimbatore by Venkataraman has made the sugar industry possible in India. The work of the Dutch plant breeders in Java resulted in doubling the yield of sugar-cane per acre with the result that the islands' production was increased by 100% without any increase in the area devoted to sugar.

More resistant and higher-yielding strains of wheat are gradually replacing the other types of wheat in India and now occupy 25% of the entire acreage devoted to wheat in India. Higher-yielding strains of rice also are being gradually introduced. In this connection attempts should also be made to develop strains of the food crops with higher nutritive values. Experience has shown that better yielding and more resistant types cost no more to grow and harvest or to tend than the poorer varieties.

The achievements of the plant-breeder on grasses and fodder crops are also very important so far as the supplies of protective foods, like milk and meat, are concerned. The selection and crossing of grasses, clover, lucernes and other fodder crops are continually making possible the increase in the number of cattle or sheep reared in farms. Thus in New Zealand, over the last three years, production of butter and meat has increased enormously without any material extension of the acreage on which the flocks and herds are depastured.

Farmers are conservative people, and the lag between scientific discovery and the full utilization of the resultant improvements in agriculture may often be as long as one or two decades; but it is hoped that with the spread of agricultural education which is very important for India, increased production will follow new discoveries with increasing rapidity. There is certainly, now, no doubt that Indian agriculture can respond to increase in demand for food as rapidly and as fully as there is any prospect of that demand arising.

The demand for protective foods is likely to improve international trade and thereby the economic condition of people which is very closely related with adequacy of nutrition. The European

countries, where already intensive cultivation on modern lines is carried on, will have to devote more land to production of protective foodstuffs and hence to import more cereals like wheats from India and other wheat-growing countries.

Before deciding on the policy of national agriculture, it is highly important that dietary surveys should be undertaken throughout India so that facts about actual consumption of different ingredients like proteins, carbohydrates, fats, etc., per head and the actual defect in nutrition may be definitely known. These surveys should, as pointed out by Sir John Russell, really be "sample surveys" and not "spot surveys," *i.e.*, there should be some definite method of selecting the villages to be studied. The following sets of data should be collected: (*i*) Statements showing the actual dietaries which can then be compared with the optimum physiological requirements; (*ii*) Records of the prevalence of various diseases caused by deficiencies of essential nutrients; (*iii*) "State of nutrition" of different population groups, *e.g.*, school children, adults, and its correlation with diet. A suitable index for measuring the state of nutrition should be evolved. The A. C. H. index adopted widely in America is not suitable for India. Records of average height and weight and other anthropometric data in the various age and sex groups should be taken; and (*iv*) Effect on "state of nutrition" of improving the diet of selected groups.

Another urgent necessity is the establishment of laboratories in different parts of India for the study of and scientific research in human nutrition. The foodstuffs of India have got to be analysed, their protein, fat, carbohydrate, mineral and vitamin contents and the biological value of the proteins determined, and the effect of methods of preparation and cooking on their nutritive value investigated. The nutritive value of diets as actually consumed has also got to be determined. Basic researches in nutrition should be a prominent feature of these laboratories. India is a vast country and the dietary habits of people in different parts are different. It is impossible for one central laboratory to deal with the different nutritional problems of the country.

The problem of nutrition in India is one which requires immediate attention. Compulsory primary education with a view to educate the mind of every individual is no doubt greatly to be desired, but the fact remains that millions of children in India are physically and hence mentally incapable of profiting by any education. The fundamental problem is to make them physically and mentally fit by ensuring an adequate nutrition for them. The State has a very great responsibility in this matter. Provincial Nutrition Advisory Boards, and a Central Nutritional Advisory Committee for all India including nutrition, agricultural, animal husbandry, educational, economic, medical and public health experts should be immediately set up. These Boards will direct diet and nutrition surveys, control and co ordinate the work of the nutrition laborotories, define satisfactory diet standards which would be of practical use in the country, suggest supplements to correct the deficiencies in diet, advise regarding the dietary aspects of maternity and child-welfare work and control and undertake propaganda through trained workers.

The Indian Research Fund Association is doing valuable work in this direction but the scope of its work should be considerably enhanced.

Corporations, municipalities, District and Union Boards and also Infant and Child Welfare Organizations can do very valuable work specially by organizing the supply of pure and fresh milk and by disseminating knowledge regarding correct nutrition, so that people in India should not only live but also enjoy the joy of living.

Earthquake Problems of India

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It is estimated that about 30,000 earthquakes occur annually over the world as a whole, so that during the Christian era about 60,000,000 earthquakes have occurred. Of these earthquakes which occur annually some are very feeble, such as would be recorded by instruments only, some would be felt locally within a radius of 50 or 100 miles of the epicentre, some would be felt over wider regions, while a small fraction would be felt over a few hundred thousand to over a million square miles. These latter are literally world-shaking earthquakes, and it is estimated that at the present time they occur at the rate of about 60 per year. It is of interest to know what India's share of this number is. To answer this question, one must examine the catalogue of all felt earthquakes in the Indian area for two or three centuries. Unfortunately no complete list of felt earthquakes is available for years earlier than the middle of the last century. A small catalogue of destructive shocks was, however, compiled from various sources by Prof. Milne and published in the Report of the British Association for the Advancement of Science, 1911. For the Indian area the chief source was the list given by Oldham in the *Memoirs of the Geological Survey of India*, Vol. XIX, part 3. Other sources were the *Records of the Geological Survey of India*, Vol. XVII, part 2, Vol. XVIII, parts 3 and 4, Vol. XXVI, part 2, *the Journal of the Asiatic Society of Bengal*, Vol. XLVII, part 2, pp. 131-140, and *Proceedings of the Asiatic Society of Bengal*, March 1883, pp. 60-66.

From the earliest historical times to the 17th century, the entries in the list are comparatively few in number as compared with entries made subsequently. If we confine ourselves to two centuries, we have the following list of 74 destructive earthquakes:—

1737	III	October 11 .	Felt in Calcutta. 300,000 lives lost.
1762	II	April 2	Felt all over Bengal, Arracan and Burma.
1764	II	June 4 .	Felt in the Gangetic plain.
1803	III	September 1	Felt at Barahal, Badrinath, United Provinces.
1808	I	April . .	Felt in Bengal.
1809	I	. .	Felt in Gurhwal.
1816	I	May 26 .	Felt in the Upper Valley of Ganges.
1819	III	June 16 .	In Cutch. 2,000 perished in Bhuj.
1822	I	June 29 .	Felt in Madras, Chittore, and Vellore.
1826	II	October 29	Felt in Nepal.
1827	III	September 26 (about).	In Punjab. 1,000 perished.
1828	III	June 6 .	In Kashmir. 1,000 killed.
1828	II	October 29 .	In Nepal.
1830	I	December 31	Chittagong and its neighbourhood.
1831	I	. .	Peshawar and Valley of Indus.
1833	III	August 26 .	Nepal, United Provinces and Bihar.
1836	I	June 24 .	In Bengal.
1839	III	March 23 .	Burma.
1842	III	February 19	Northwest India. Felt from Kabul to Delhi.
1843	III	April 1 .	In Deccan.
1845	I	April 19-25	In Cutch.
1845	II	June 19 .	Delta of the Indus.
1845	I	August 6 .	Assam.
1846	I	October 18	Mymensingh, Calcutta, Serampore.
1852	III	January 24 .	Upper Sind.
1852	II	May . .	Darjeeling.
1856	I	April 7 .	Kangra, Simla, Kotghur.
1856	I	December 25	Bombay, Surat.
1858	I	August 11 .	Simla.
1858	II	August 24 .	North Burma, Prome, Akyab, Kyaukpyu.
1861	II	July 31 .	United Provinces.
1861	I	August 26 .	United Provinces.
1865	I	December 19	Southeast Bengal.
1866	II	May 2 .	Nepal.
1867	I	July 3 .	Madras, Villupuram.
1868	I	August .	Peshawar.
1869	III	January 10 .	Assam (Silchar, Cachar).
1869	I	April .	Peshawar.
1869	III	July 7 .	Nepal.
1869	I	December 20	Rawalpindi.
1870	I	April 22 .	East Bengal.
1870	I	October 28	Sind.
1872	III	December 15	Baluchistan.
1875	I	April 26	Darjeeling.
1875	II	December 12	Lahore, Peshawar.
1878	I	March 2 .	Punjab.
1881	I	December 31	Epicentre Bay of Bengal. Felt over an area of 2,000,000 square miles, sea and adjoining land.
1882	II	October 13 .	Assam.
1883	II	April .	Peshawar.
1885	I	January 15	Kashmir.
1885	III	May 30 .	Kashmir (2,000 lives lost).
1885	III	June 6 .	Kashmir.

1885	II	July 14 .	East and middle Bengal.
1885	II	July 24 .	Bengal.
1886	I	October 20 .	Kashmir.
1888	I	October 10 .	Burma.
1888	I	December 23	South Bengal.
1888	II	December 28	Baluchistan.
1891	I	June 17 or 18	Bengal.
1892	III	December 20	Chaman, Baluchistan.
1893	I	November 5	Punjab and North-West Frontier Provinces.
1894	II	Dec. 13 & 14	Burma.
1897	III	June 12 .	Assam.
1899	II	September 25	Darjeeling.
1905	III	April 4 .	Kangra.
1909	II	October 21 .	Baluchistan.
1912	III	May 23 .	Burma.
1918	III	July 8 .	Srimangal, Assam.
1929	I	February 1	Northwest Himalaya.
1930	III	May 5 .	Pegu (Burma).
1930	III	July 3 .	Dhubri (Assam).
1931	III	August 27 .	Mach, Baluchistan.
1934	III	January 15 .	North Bihar.
1935	III	May 31 .	Quetta.

The numerals I, II, III given against each earth quake represents its intensity in order of increasing severity. 'I' means that the earthquake had an intensity sufficient to crack walls, break chimneys, shatter old buildings or to produce slight cracks in the ground. This is roughly equivalent to an acceleration of 3 feet per sec. per sec. An earthquake of intensity 'II' would uproot or shatter buildings, cause bad cracks in ground, or landslips. Acceleration of the ground will be roughly of the order of 5 feet per sec. per sec. Earthquakes having intensity 'III' are those which destroy towns or devastate districts; the acceleration of the ground in these cases exceeds 5 feet per sec. per sec. In the earthquake in North Bihar on Jan. 15, 1934, the acceleration of the ground within isoseismal X was about 10 feet per sec. per sec. The following is the geographical distribution of the list of earthquakes:

Burma	6	Baluchistan	6
Bengal and Assam	22	Sind	3
United Provinces, Bihar and Nepal	11	Gujarat	2
Punjab and North West Frontier Provinces	11	Bombay Presidency	2
Kashmir	5	Madras	3

Classified according to intensities, we had 31 earthquakes of intensity 'I', 18 of intensity 'II' and 25 of intensity 'III'

If earthquakes continue to occur at the rate at which they occurred during the last two centuries, we may expect about 37 destructive earthquakes during the next century in Indian area, or roughly about 1 in 3 years. We may expect also that out of these 37, there will be about 12 which will cause widespread destruction. This gives us a frequency of 1 in about 8 years of earthquakes, each one of which might cause damage worth crores of rupees and terrible loss of life. This is the problem which India has to face and the problem is nowhere more acute than in Bengal and Assam.

The first question which one asks oneself is: Where do these earthquakes originate, and what is their cause? To this question no final reply is yet available, but we have now reasons to believe that the foci of some of these earthquakes are near the surface while those of some of the others are fairly deep. In a paper on the depth and geographical distribution of deep focus earthquakes[1] Gutenberg and Richter give the following list of earthquakes in and near the Indian region, which are identified as deep-focus:

Date.		Time (G.M.T.) h. m. s.	Epicentre. Lat.	Long.	Depth KM.
		Assam-Burma.			
1927	March 15 . .	16.56.32	24.5N	95E	130
1932	August 14 . .	04.39.32	26N	95.5E	120
		Hindu Kush.			
1907	December 25 .	22.36.00	36.5N	70.5E	240
1917	April 21 . .	00.19.49	37N	70.5E	220
1921	May 20 . .	00.13.20	36N	70.5E	220
1921	November 15 .	20.36.38	36.5N	70.5E	215
1922	December 6 . .	13.55.36	36.5N	70.5E	230
1924	October 13 . .	16.17.45	36N	70.5E	220
1925	June 20 . .	13.04.15	36.5N	71.5E	230
1925	December 18 .	18.10.25	36.5N	71E	230
1927	July 15 . .	03.46.43	36.5N	70.5E	250
1928	August 10 . .	15.33.48	36.5N	70.5E	230
1928	November 14 .	04.33.09	35N	72.5E	110
1929	February 1 . .	17.14.26	36.5N	70.5E	220
1929	March 3 . .	03.11.02	36.5N	71E	250
1930	September 11 .	17.20.16	36.5N	70.5E	250
1931	January 20 . .	09.27.22	36.5N	71.5E	220
1931	August 15 . .	01.01.08	36.5N	70.5E	240
1931	October 5 . .	22.31.27	36.5N	70.5E	220
1933	January 9 . .	02.01.13	36.5N	70.5E	220
1934	July 22 . .	19.56.57	36.5N	70.5E	240
1934	November 18 .	03.21.24	36.5N	70.5E	220
1936	June 29 . .	14.30.10	36.5N	71E	230
		Baluchistan.			
1929	September 3 .	12.07.39	26.5N	62.25E	110

[1] *Bulletin of the Geological Society of America*, 49, February, 1938.

The twenty shocks from nearly the same focus in the Hindu Kush constitute a remarkable series. There is a surprising persistence in activity from this source. We have thus two distinct regions, namely the borderland between Assam and Burma and certain part of Baluchistan in which the earthquake foci have depths between 100-130 Km. There is a third region in the neighbourhood of the Hindu Kush, where the depth is generally between 220-250 Km. Earthquakes having normal depth of less than 50 Km. have been recorded in these regions. Ramanathan has independently collected a series of seismograms in relation to some of the deep-focus earthquakes in these regions.[2] He concludes that the depths of the original disturbances of many of the earthquakes in the region of the Khasi and Jaintia Hills are 60 to 80 Km. Elsewhere in the Indian area, all earthquakes have normal depths; at any rate no deep-focus earthquakes have yet been identified.

It has been suggested that the causative mechanism of normal and deep shocks is probably the same. The deep shocks show no surface waves, but in other respects the deep and normal shocks show similar characteristics. Both types of shocks appear to be due to a sudden release of growing strain. It has been held by some that the large shear waves observed in both types of shocks would indicate that neither of them could be due to sudden explosion. Such a conclusion would be reasonable if the action of the deep-seated bathyseism which would produce such an explosion is assumed to be perfectly symmetrical about a centre. When the explosion causes fractures in rocks in an irregular manner, the production of shear waves is not excluded.

The waves which each earthquake sends out in different directions bring with them information not only about its depth, but also about the earth's interior as well as the crustal layers, provided we have the means of recording and studying them. The following are the phases which are now readily recognized in seismograms (figs. 1, 2, 3):—

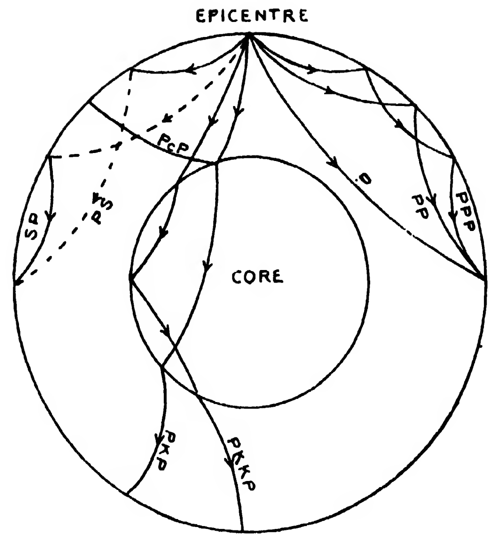

Fig. I

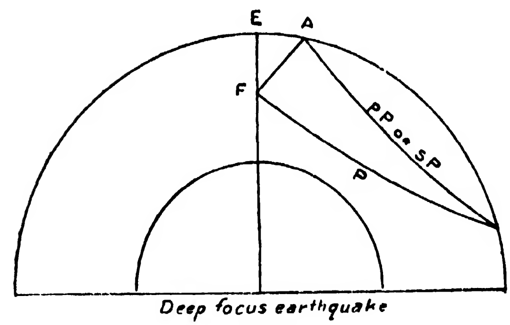

Fig. II

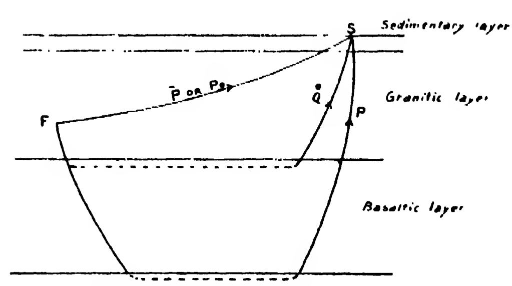

Fig. III

[2] *cf. Proc. Ind. Science Congress*, Part II Calcutta, 1938, p. 13.

P	=	First preliminary tremors, longitudinal waves that have passed below the crustal layers.
P or *Pg*	=	*P*-type waves, whose path does not go below the lower boundary of the granitic layer.
*P**	=	*P*-type waves diffracted or refracted below the first major discontinuity in the crust of the earth, (boundary between the granite and the intermediate layers).
PP	=	*P*-waves reflected once at the earth's surface.
PPP	=	*P* waves reflected twice at the earth's surface.
S	=	Second preliminary tremors, transverse waves which have passed below the crustal layers.
S or *Sg*	=	*S*-waves whose path does not go below the lower boundary of the granitic layer.
*S**	=	*S*-waves diffracted or refracted below the first major discontinuity in the crust of the earth (lower boundary of the granitic layer).
SS	=	*S*-waves reflected once at the earth's surface.
SSS	=	*S*-waves reflected twice at the earth's surface.
PS & *SP*	=	Waves transformed from *P* to *S* (and *vice versa*) on reflection at the earth's surface.
K	=	Symbol used to indicate part of the path which lies inside the earth's core when it is traversed as *P*-wave. (The old symbol for this is *cPc*).
PKP or P'	=	*P*-waves that have traversed the earth's core.
PKP_1 & PKP_2	=	The two branches of *PKP*.
PKKP	=	*P*-waves in the mantle refracted and internally reflected in the core.
SKS	=	*S*-waves transformed as *P*-waves when entering the core and re-transformed as *S*-waves when leaving the core.
SKKS	=	*S*-waves in the mantle refracted and internally reflected in the core as *P*-waves.
PKS	=	*P*-waves refracted through the core but transformed into *S*-waves when leaving it.
PcP	=	*P*-waves reflected from the outer surface of the core.
ScS	=	*S*-waves reflected from the outer surface of the core.
PcS, *ScP*	=	Meanings are similar to *PS*, *SP*, but refer to waves reflected at the outer boundary of the core.
G	=	Fast surface shear waves (after Gutenberg)).
L	=	Long surface waves of irregular form at the beginning of the " principal phase."
M	=	Shorter and more regular surface waves of large amplitude which follow the *L* waves.
M_1	=	First maximum in the surface wave phase.
M_2, M_3, etc	=	Second, third, etc., maxima in the surface wave phase.
F	=	End of discernible movement.

Special phases of deep-focus earthquakes.

pP	=	*P*-waves from a deep focus reflected at the earth's surface near the epicentre.
sP	=	*S*-waves from a deep focus reflected at the earth's

surface as P-waves near the epicentre.

pS = P-waves from a deep focus reflected as S-waves near the epicentre.

sS · S-waves from a deep focus reflected as S-waves near the epicentre.

$pPcP$, $sPcP$, $pScS$, $sScS$, etc. have similar significance.

It is easy in many cases to note whether a phase had an impulsive or sharp beginning or whether the phase emerged gradually. In particular, by a careful examination of the first phase we can often say whether the shock began with an initial dilatation or compression. All these furnish most valuable information regarding the origin of the earthquake. It is well known that the seismographs in India are too few for detailed analysis of local earthquakes. Most of these, being of the Milne-Shaw type, are not provided with a sufficiently open time-scale. In near earthquakes the phases get crowded together and a more open time scale is needed to distinguish them. Moreover, there is no vertical seismograph in India, and our information about earthquake phases and their relative intensities in the three components is, therefore, always incomplete.

A question which is of very great practical importance is: What displacement and acceleration are produced in the ground by our most violent earthquakes, as on this question depends the safety of our existing houses and other structures and also the specifications of our future buildings. Answers to this question have been provided to a certain extent by indirect methods during post-geological survey of earthquakes, but there are now excellent strong-motion displacement and acceleration seismographs available. Many of these are in use in Japan and America. There is none in use in India. Each of these instruments which respond directly to the earthquake has a starting device, an automatic recorder, a time-marking clock, the necessary optical system and lighting arrangement, electric circuits and batteries. The automatic starting device and some of the special features of the automatic recorder are necessary in order that the instruments may remain in a state of inactivity until an earthquake occurs and then instantly start making the record of the movement.

A line of development which has been carried on in Japan is the measurement of earth tilt as an indication of what may be going on. Several types of tiltmetres have been developed and used in Japan for this purpose. In America tiltmetres have been developed using the principle of interferometry, the sensitivity being so arranged that a change of one fringe between crosshairs represents a one-second change or one-half-second change in tilt.

If the best practical use is to be made of the seismic data, there must be simultaneously a survey of the vibration characteristics of different types of buildings as well as of bridges and bridge piers. This will be clear from the following consideration. It is obvious that if the height to width ratio of a building is very large, flexural distortions are of importance and shear may play a small role. But just how large this ratio must be before shear may be neglected requires an experimental answer. It is also necessary to determine the effect of a yielding foundation on the periods of a vibration of a building, a translatory yielding, a rotatory yielding, and a torsional yielding. In Japan and America, the vibrator and vibrogram programme constitutes an important adjunct to earthquake research.

In this branch of geophysics, we have a vast field for work in India. Most fruitful results are bound to be obtained in the interesting mountain ranges of Assam and of the North-West-Frontier where we get normal as well deep-focus earthquakes. We may get an answer to the question why repetition of shocks from nearly the same focus occurs within a comparatively short time, a few months or years. In his presidential address delivered in the Section of Geology and Geography of the twenty-fourth Indian Science Congress, (Hyderabad), 1837, West has given an excellent review of the relationship between earthquakes in India and its geological structure. He shows that almost all severe earthquakes are located along the flanks of the Himalayas and its associated

ranges, while none occur in association with the older Aravalli, Vindhya or Satpura ranges of Peninsular India. The fact that the formation of mountain ranges is inevitably accompanied by the fracturing of the rocks along faults and overthrusts and that earthquakes can sometimes be definitely correlated with movements along faults explains the association of earthquakes with recently formed mountain ranges, or with those that are in process of formation. The balance of evidence suggests that most earthquakes originate in movement along faults, though the nature of the faulting may be variable and not necessarily connected with folding. The mountain ranges in Baluchistan and in Assam show interesting peculiarities. In Baluchistan there is a peculiar re entrant angle in the alignment of the hills, and West suggests that this has probably been caused by an underground tongue of Peninsular India obstructing the free movement of the fold towards the southeast. The Archaeon block of the Assam range slopes gently northwards and is believed to underlie the entire Brahmaputra Valley of Assam, with relatively thin covering of alluvium. This fragment of Peninsular India, according to Fox, is rent by cross faults tending north and south which have sliced the block into fragments that have been pushed southwards in echelon. One of these faults is the Chadrang fault which was formed during the great earthquake of 1897. In his account of the Dhubri Earthquake of 1930, Gee expressed the opinion that lines of fractures have been developed along the northern border of the Assam range as a result of the advance of the Himalayas towards the south, and that a definite zone of structural weakness exists there. How is the strain produced in the Hindu Kush at a depth of 220-250 Km? Would the occurrence of both normal and deep focus earthquakes in Assam, in Baluchistan and in the Hindu Kush be accounted for by a slow displacement, which persists for long periods of time, of blocks as a whole which cover wide areas and have considerable depth? Gutenberg and Richter remark in the paper referred to above that such a view "is consistent with the geological evidence of similar displacements along parallel or nearly parallel faults over extended areas, such as has been found in California. These displacements have been discussed recently by Buwalda (1937). In searching for a possible cause of such regularity of displacements, one notes that the accumulation of epicentres of both normal and deep shocks about the margins of the continental blocks suggests a motion of each block as a whole—a motion which may be a rotation, a displacement, or both. The fact that the deeper shocks occur farther inland from the continental margins than the shallower ones may be explained by assuming that the load of the continents produces an outward plastic flow towards the Pacific Basin at the surface, with a compensating movement in the opposite direction at depth. Such movements are, of course, much slower than the accumulation of the strains in other directions, which are released in earthquakes."

For a determination of the precise nature of the shearing or faulting movements of the type pictured above we need records from a net-work of seismological stations in these regions. It is also necessary to carry out seismic prospecting in the regions to determine the lay-out of the crustal layers from time to time.

The Origin of Wheat and a few other Cultivated Plants

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THE nature of the steps through which man first learnt to grow his own food or, in other words, began to cultivate, will ever remain obscure. We may, however, imagine that at first he liked the seeds of certain wild grasses and began to collect them. Then by a very big advance he sowed the seeds and readily obtained more of them than by relying on those that grew spontaneously. This process must have taken very long in the nomadic or semi-nomadic conditions prevailing at the time. Later under favourable conditions the people settled in some places and began to practise systematic agriculture. Hints about these stages may be obtained from observations. Only about 75 years ago in the Punjab the poorer classes and the nomads were accustomed to use the seeds of wild grasses for their food—the fallen seeds being " swept up into straw baskets." Till recently the Red Indians of America used to beat out and collect the grains from the wild rice *Zizania aquatica* but they were also careful to scatter some of the seeds for future crops.

After agriculture was once established attention was probably directed towards the acquisition of more suitable grains and this gradually resulted in the production of crops differing markedly from the original wild forms. This, in the case of wheat and a few other crop plants, must have taken place in a very distant past. For the earliest records in our possession show wheat and other grains very little different from the present ones. At Mesopotamia from a Sumerian house of about 3500 B.C. a fine red and black jar containing wheat was found. Similar findings have also been made from the oldest Lake-dwellings of Switzerland and the Egyptian tombs (3,000—4,000 B.C.) Wheat has also been found in the 4000-year-old Mohenjo-daro Civilization of India.

Considering this antiquity of wheat cultivation it is naturally difficult to ascertain the source and place of its origin; especially when we know that it is grown all over the world and that there are numberless varieties. According to Percival, " No month passes without a crop of this cereal being harvested in some region or the other." In the U.S.S.R. Institute of Plant Breeding on Dec. 28, 1933, Vavilov had 29,700 varieties under cultivation and he believed that the number of existing forms had to be counted in millions. These numerous forms are, however, varieties of the 13 known species of wheat which can easily be placed in three main groups:—

(1) The One-grained wheat *Triticum monococcum* also known as " Eincorn " or " small spelt." It is grown as a forage crop and is also eaten. It is very hardy but produces dark-brown bread. The number of chromosomes in ordinary cells is 14.

(2) The "Emmer" group or "Hard" wheats—There are seven species including *Triticum dicoccum* (emmer wheat), *T. durum* (macaroni-wheat—the second most widely cultivated species) and *T. turgidum* (rivet- or cone wheat). These are called " hard " wheats because when the grains are broken they present a steel-like appearance due to less moisture. These are difficult to grind but, when milled, yield a larger percentage of flour. They contain more gluten and so are of better baking qualities. The number of chromosomes is 28.

(3) The " Soft " or Bread-wheat group—This has 4 species including the common wheat (*T. vulgare*) and *T. compactum* (club or hedgehog wheat). These are " soft " wheats because the interior is white and mealy due to a larger percent-

age of water. The yield is generally more than the "hard" wheats. The number of chromosomes is 42.

Vavilov's Work

During the rebuilding of Russia after the socialistic revolution, the Soviet wanted to plant the best available varieties for their agriculture. Before this the Russian peasants like their Indian brothers of to-day sowed their fields anyhow. They sowed weeds together with grains, infected seeds along with good seeds and planted many varieties all together. Expeditions were sent to different places to collect the available varieties. In 1924 N. I. Vavilov, now director of the State Institute of Experimental Agronomy of Russia, with two other scientists set out for Afghanistan which was by that time very little explored. Travelling through this rough and dangerous country, infested with bandits, and without any maps or roads, they found on the top of the mountain ridges, mainly at an altitude of 5000 ft., many unknown and new varieties of the group of "soft" or Bread wheats. Some had awns (beards) which were very big while in others they were short or lacking. The colour of the head varied from white to red, bluish or black, and the grains exhibited all kinds of shape, size, and colour. Sometimes as many as 15-20 varieties were found growing in a single field. Struck by the great diversity of forms in a country where only 2% of the land is under tillage, Vavilov tried to explain his findings by assuming this place to be the centre of origin and distribution of this group of wheats. Ages ago "soft" wheat originated from its parents in some unknown way in this country, and the people began to cultivate it. In the course of thousands of years they obtained many different kinds, some or other varieties of which were specially liked and taken to different countries by the caravans of traders, migrating people and conquering hordes (like the armies of the Assyrians, Alexander or Chengiz Khan). Thus they spread north, south, east and west, but only fewer and fewer varieties could reach the more and more distant places. Only in their native land the representatives of all the varieties were preserved. This theory of Vavilov finds corroboration from evidences from (1) archæology, chiefly of the ancient routes of the caravans and invaders, (2) history, especially from the ancient manuscripts, and (3) above all from the distribution of the species and varieties found all over the earth. If we analyse the number of forms of soft wheat grown at different places we see that only a few varieties are found in Europe and North and East Asia, where the same kinds occur again and again. But as we approach the regions of South-West Asia like Persia, we notice many more different varieties until when we reach the eastern Afghanistan and the Punjab we find the number of varieties to be enormous, there being about 50 varieties of *T. compactum* and about 60 of *T. vulgare*, as compared to about 32 found in India and only 12 in Italy of the last species. Vavilov also noticed that not only the number of varieties was large but most of the characters (coloured ears, hairiness) were such that they behave as dominant characters in hybridization. The farther we recede from this centre of distribution the more recessive characters do the varieties show.

Pursuing his arguments on exactly similar lines Vavilov showed that the "emmer" or the "hard" wheats originated in East Africa specially in Abyssinia. No plant from this group is found in Afghanistan even as admixtures but in Abyssinia more than 40 varieties of the "emmer wheat" with clearly dominant characters are observed. Thus, according to Vavilov, the present-day cultivated wheats have a duel centre of origin—the "Hard" wheats originated in Abyssinia and the "Soft" wheats in Afghanistan. This double origin is also indicated from another source. As has been pointed out before, the two kinds of wheat are not genetically alike (the former possessing 28 chromosomes and the latter 42) and hybridize only with difficulty which points to a separate origin. The first group—one-grained wheat—is not much cultivated and probably originated in Asia minor.

Though the place of origin has thus been found out with more or less certainty, the actual parents of the wheats of to-day are not known. There are several views about their origin:—(1) Derived

from wild species now extinct or possibly awaiting discovery; (2) greatly changed descendants of common wild forms (Fabre), or (3) according to Schulz these originated from various groups rather than from a single species or group. The origin of the one-grained wheat is fairly certain and it probably arose from the wild grass *Triticum aegilopoides* found in Palestine and Mesopotamia. Another wild grass *Triticum dicoccoides* was discovered by Aaranosohn in Palestine in 1906, who called it " wild emmer " and attributed to it the parenthood of the " hard " wheats, but Vavilov does not accept this view. The origin of the " Soft " wheats is also shrouded in mystery. According to some, these have originated not from any wild form but from the "emmer" group either directly (Aaranosohn) or through hybridization between the " emmer " wheats and some wild grasses. According to Vavilov and others, their ancestors await discovery somewhere in Afghanistan or North-West India. Taking into consideration what has been said previously, the last view seems to be more plausible.

Barley is also another ancient crop having been found in the Egyptian monuments. There are two groups—the 2-rowed and the 6-rowed ones both of which probably arose in Palestine and Arabia from the wild form *Hordeum spontaneum*.

Rye used to be grown mostly as a forage crop but, in Russia, had become almost the chief grain due to its hardiness and ability to withstand severe cold. Though least ancient its origin is uncertain but some believe the wild species *Secale montanum* found in the mountainous regions of the Mediterranean to be the parent. According to Vavilov, Afghanistan, where it occurs as weed, is the place for its origin and distribution as there are a number of endemic varieties. One such variety is called the Scattering rye. The stalk of the head is very brittle and before the wheat is ready for harvest its head breaks to pieces and the grains are scattered. Thus its seeds are rarely found mixed with wheat, and so it has never left the land of its birth. On the other hand, the non-scattering varieties were harvested along with wheat and carried away by caravans and traders. In the northern Russia both were sown together, but due to the intense cold the wheat did not grow and the people were forced to eat the black bread made from this weed which survived. Such behaviour strengthened the superstitious belief that wheat could degenerate into rye.

Oat is also another crop of recent origin, being probably first cultivated in the Bronze Ages in Mid-Europe. According to Vavilov, it orginated from weeds growing along with the cultivated cereals and the different species probably arose at different geographical centres from different ancestors. As in the case of another weed rye, people supposed oats also to originate through degeneration of wheat. Pliny in 1601 wrote, "The first and principal defect observed in bread corne and wheat especially, is when it doth degenerate and turne into Otes: and not onely it, but Barley doth the like."

Rice constitutes the staple food for more people on this earth than any other crop. Prehistoric in origin, its earliest records are found in the oldest Chinese writings. It is essentially tropical and evidences point to South East Asia as its probable home though some wild forms are found in South America.

Potato reached Europe at the close of the 16th century when a traveller from America brought back some of the smaller varieties that were accommodated in his pocket though bigger ones were possessed by the Red Indians. These became the forefathers of all the cultivated potatoes of Europe and even of the world because some were sent back to North America and the people of the U.S.A. now eat potatoes that have ' twice crossed the Atlantic.' Taking the number of forms and their diversity as criteria for the centre of origin Yuzepchuk and Bukasov, members of the Russian expedition in 1929, determined Chili and the Peru-Bolivian region as the probable home of this crop. Here they found more than 12 cultivated and 30 wild species in place of the previously known single cultivated one. This finding is supported by striking evidences of a Megalithic civilization in that region.

The sugarcane had probably two centres of origin. The thick or " Noble " varieties originat-

ed in Oceania and New Guinea but their parent is not known. The other variety—the thin or Indian canes according to Barber, originated in India in the neighbourhood of Bay of Bengal from the wild species *Saccharum spontaneum* (Kās). Sugarcane cultivation is very ancient in India. In the laws of Manu we find "stealer of sugar will be punished in the hereafter by becoming a bat; nevertheless if a 'twice born' man, while on journey, finds his provisions exhausted, it is lawful for him to take two sugarcanes from the field of another."

We may now consider some of the important generalizations resulting from the application of Vavilov's methods of geographical distribution of characters in the study of the origin of crops. Firstly, it has been shown that the cultivated plants fall into 2 groups: (1) primary crops which include all the ancient crops known only from cultivation. These are wheat, barley, rice, soyabean flax, etc.; and (2) secondary ones, which originated from the weeds mixed with the primary crops as rye, oats, etc. Next Vavilov has come to the surprising conclusion that "mountainous districts were the home of agriculture rather than the traditional view of river-basin areas." That is to say, agriculture started in the mountains and only later spread to the river-valleys. From a study of the distribution and origin of all the cultivated crops, he has shown that there are 5 principal centres of their origin and all are situated in the mountainous regions. These are:—

(1) South West Asia (The Hindukush and the Himalayas)—Bread-wheat, rye, small seeded flax, leguminous crops, such as peas, lentils, etc., old-world cotton, turnip, radish and carrot, onions, apricot, peach, pomegranate, walnut etc.

(2) South East Asia—Millet, soyabean, rice, sugarcane, sorghum, tea, and fruit trees, such as banana, citrus, etc.

(3) Coastal regions of the Mediterranean—"Eincorn" wheat, large seeded flax, beet, olive, cherries, fig and nuts.

(4) North-East Africa—"Hard" wheats, barley, beans and forage plants, doob-grass, some millets, sesame, castor, and coffee.

(5) Central and South America—Maize, potato, tobacco, new-world cotton, ground-nut, rubber and cacao.

In this connection it may not be out of place to mention that in a recent paper (*Nature*, Jan. 11 & 18, 1936) Dr Hamshaw Thomas suggested that the origin of the great variation found on the mountains may be due to the greater intensity of the Cosmic rays and the frequency of their showers in those places.

Vavilov has also shown that most of the dominant characters found in the different varieties are concentrated at the centres of distribution and the geographical spread has resulted in a process of simplification and liberation of the recessive characters.

The value of Prof. Vavilov's methods to practical plant breeding has been enormous. He has shown to us where to look for new varieties possessing new and desirable characters which, if necessary, may be combined with the characters of our cultivated plants and make them better yielding. Not only this. If his conclusions stand the test of further work, it can easily be extended to the study of the history of man and his domesticated animals. It can be noted that most of the five principal centres of the origin of crop plants, enumerated above, are also the places where the different coloured races are concentrated. Like the crops of these places the coloured races also possess characters (darker skin, curly hair) which are clearly dominant. And just as the colour of the crops (cereals) become lighter as we go farther away from their centres of distribution so the human types also lose their pigmentation. Thus an important clue to the beginning of civilization has come from an entirely unexpected source. Though of such great theoretical and practical importance Prof. Vavilov's works are mainly in Russian but it is gratifying to note that he himself is writing an article in English which will be awaited with interest.

THE ORIGIN OF WHEAT AND A FEW OTHER CULTIVATED PLANTS

The following publications have been consulted for materials:

(1) Ilin, M.—*Men and mountains*. London.

(2) Martin & Leake *Recent Advaces in Agricultural Plant Breeding*. London. 1933.

(3) Arber, Agnes—*The Gramineae*. Cambridge, 1934.

(4) Haldane, J. B. S. *The Inequality of Man*. London, 1932.

(5) *Nature*—Various issues.

(6) *Biological Abstracts* Various issues.

Twenty Years of Soviet Optics

V. M. Tschulanovsky

[*"Twenty Years of Soviet Optics" is the article following "Twenty Years of Soviet Physics," reproduced in our last issue from the "Physikalische Zeitschrift der Sowjetunion". In this article V.M. Tschulanovsky (l.c., 12, pp. 506-525, 1937) gives a resumé of the work done in the field of Optics during the last twenty years in the Soviet Union.*

—*Ed., Sc. & Cul.*]

THE foundation of large-scale Soviet optics was laid shortly after the October Revolution. Before the War of 1914 work on optics was carried on in Russia by a few scientists almost exclusively in university laboratories, without great prospects of development, with little mutual contact and without any relations whatever to the problems of industry.

At the Physical Institute of the St. Petersburg University D. S. Rojdestvensky was then pursuing his investigations on anomalous dispersion, which have since become classical. Golitsin worked in the Academy of Sciences on several spectroscopical subjects, such as the Doppler effect, the structure of mercury lines, the theory of the échelon spectrograph, etc.

Various optical subjects were treated in Moscow, in the laboratory of P. N. Lebedev, among them in the first place the work on light pressure by Lebedev himself. In the same laboratory T. P. Kravets investigated regularities in the absorption of light by organic dyes. P. P. Lasarew established the fundamental laws of photochemical reactions connected with the bleaching of dyestuffs. Eichenwald worked on the theory of the passage of light from one medium to another.

Goldhammer at Kazan worked on various optical questions, among them the theory of the anomalous dispersion.

The optical industry was then in an embryonic state. Optical glass was not manufactured in pre-War Russia, just as in most other countries. Optical instruments, almost exclusively for war purposes, were manufactured in negligible quantities. Their manufacture depended to a large extent on the foreign capital. There was only one man in the country, A. L. Gershun, who knew how to calculate an optical system. The War showed

that such a state of affairs was catastrophic and could no longer be suffered. Urgent measures were taken. In particular recipes for manufacturing a number of optical glasses were purchased in England and attempts were made to obtain such glasses in Russia. However these attempts had very little success. The Soviet regime first proceeded to organize optics on a large scale and to create conditions for its development. The most important step in this line was the foundation of a State Optical Institute in 1918, which became and still is the centre of applied and scientific optics in this country. From the very outset the State Optical Institute was planned to be a complex Institute. This idea found expression first in the fact that the Institute united several organizations which were dealing with optics. Among them were a part of the Sub-Commission of Microscopy of the Commission of Natural Productive Forces of the Academy of Sciences, the laboratory and the Computation Bureau of the porcelain works, the school of D. S. Rojdestvensky at the Physical Institute of the Petrograd University. Moreover several specialists from other institutions were invited. This complex principle proved to be sound and has been maintained up to the present day.

In a great measure this arises from the peculiarity of optics as a branch of science. The main features of the science of light were developed about a century ago. The properties of light were found to be very simple, while the interactions of light with the various forms and species of matter are very diverse. The human eye is a most perfect instrument for the perception of light; it permits the perception of the properties of such objects (very remote or very small) which no other organ of sense can reach. For all these reasons optics had long ago become an applied science in the wide sense of the word.

There is no branch of knowledge or industry in which optical methods were not directly or indirectly employed or could not prove helpful. On the other hand, the optical methods are not very numerous and there is but little difference among them. The development of these methods in one field always stimulates their development in an adjacent field. The form of a spectrometer or a photometer varies with the object in view; but they are equally necessary in investigating the properties of matter, in manufacturing optical glass, for lighting technique and photographic purposes and even for instrument-making. This is the reason why in the State Optical Institute the centripetal forces always prevailed over the centrifugal forces, and it is one of the features of its development. The work of the Optical Institute always developed along these two lines: (1) the search for new applications of already known interactions between light and matter (chiefly in purely technical work), and (2) the study of new, quantum interactions between light and matter (mostly in purely scientific work). The borderline between these two basic directions was never very distinct nor very constant.

From the outset the manufacture of optical glass and the calculation of optical systems took the foremost place in work of the technical departments of the Institute. At the present time, owing to the work of the State Optical Institute partly in its own laboratory and partly in conjunction with the Leningrad Factory of Optical Glass, the problem of optical glass is entirely solved in the USSR.

The Computation Bureau of the State Optical Institute has mastered the calculation of all the principal species of optical instruments and computed a number of its own designs, some of which were rather complicated. The office worked in close contact with the various plants of the Union. The computation of optical systems, which began to develop in and around the State Optical Institute, has attained a high scientific level in our country.

Some years after the foundation of the State Optical Institute, a small photometric and optotechnical department was formed within it. Now the problems of lighting technique and projecting are dealt with in special laboratories which have split off from the photometric department. Work on colorimetry was carried on successfully for some time. The photometric department also gave birth to the laboratory of physiological

optics. This laboratory has done much to bring the work of oculists to a higher level.

The optotechnical department now occupies the central place in the system of the State Optical Institute. It began its work with measuring and testing the foreign-made optical systems. At present its main task consists in devising and testing original Soviet systems, in elaborating methods of control, working out the technological processes of the manufacture of optical instruments and in constantly helping the factories.

The technical work of the State Optical Institute is becoming more and more closely interwoven with the problems of industry. This fact is reflected by the increasing number of topics of research proposed directly by industry as well as by the increasing amount of time which the collaborators devote to the work immediately at the factory.

In this brief outline we cannot enumerate all the fields of applied optics in which the Optical Institute has played an important and sometimes a decisive role, nor we cite all the names connected with the most important achievements of the Institute. We can but mention the departments of photography, applied physical optics and the astronomical laboratory, which have carried out much and sometimes very complicated work. Those who desire more information may find it in the brief survey of the works of the State Optical Institute, " Material for the Report of Members of the Academy S. I. Wavilow and D. S. Rojdestvensky at the March Session of the Academy of Sciences of the USSR, 1936." The survey has been published by the Academy of Sciences of the USSR.

The investigations of D. S. Rojdestvensky opened the second line of work of the Optical Institute, the study of quantum interaction between light and matter. In a series of papers beginning in 1919 D. S. Rojdestvensky, independent of western scientists, applied and developed the fundamental conceptions of Bohr's theory for the case of many-electron (chiefly monovalent and bivalent) atoms.

A characteristic feature of the subsequent period is the radical change in our views on the structure of matter. The first years of this period were years of exceedingly rapid development of Bohr's theory and its mathematical apparatus. But afterwards it became more and more evident that this theory could account for only a small fraction of atomic phenomena. It became evident that the application of Bohr's theory continually evoked new contradictions. Finally, the concepts of Bohr's theory were replaced by wave-mechanical concepts. A long list of papers pointed to the possibility of correlating the results of the wave theory of matter with the phenomena of atomic physics. This work, which arose from the difficulties encountered in quantitatively explaining, according to Bohr's theory, the electronic properties of simple three-electron lithium, of two-electron helium, finally enabled us to compute by wave-mechanical methods the energy levels of complex atoms, to understand the essential properties of the molecule, to apply spectral observations in estimating the stability of the molecule, in studying elementary reactions, etc. The State Optical Institute took an active part in this work by solving a number of physical problems and elaborating new methods and apparatus.

The main subject of research at first was the atom. The method for studying the properties of its electronic shell is spectrography. The major part of the work on this line was carried out in the Optical Institute by S. E. Frisch and his coworkers. They studied the magnetic splitting of lines and worked out schemes for the spectra of neon and ionized sodium. It was the first case in which the spark spectrum was found to be more complicated than the arc spectrum. Recently Frisch gave a partial analysis of the cerium spectrum.

In his first works A. N. Terenin developed for the same purpose and successfully used for a number of atoms the method of optical excitation. To the same group belongs the work of V. M. Tschulanovsky, who explained on the example of helium the lines arising in the electric field and gave a method of determining the " infra-red terms " in the visible spectrum in an electric field.

It has long been known that the usual serial possibilities are insufficient for the full explanation of the spectra, *e.g.*, for that of the so-called hyperfine structure of spectral lines. To the small number of previously known hyperfine structures A. N. Filipov and E. F. Gross added those of rubidium and ionized caesium. Gross and Terenin studied the hyperfine structure of mercury lines under optical excitation. Terenin and L. N. Dobrezov discovered almost simultaneously with Schuler abroad the hyperfine structure in the sodium spectrum, a particularly simple and important case from the point of view of theory. After the theory of this hyperfine structure of spectral lines had been given by Pauli, Frisch and his co-workers in the State Optical Institute carried out a long series of investigations which provided ample experimental material in this field; Frisch was also the first to establish the simple relationship between the character of the moment of the nucleus and the number of elementary particles in the nucleus. During the last few years the work on the systematization of atomic spectra was transferred to the most difficult domain, the rare earths. Their peculiarity lies in the fact that the electrons determining the most important part of the luminescence of these substances are inside the shell (the incomplete shell of $4f$ electrons), while the chemical properties depend on the external electrons. In this field very important results have been obtained by A. N. Filippov, Y. I. Larionov and A. N. Seidel (State Optical Institute). It was shown that the fluorescence of terbium and europium in solution was independent of the choice of the salt of these substances. The multiplet structure observed in the spectrum proves that in the luminescence the same energy levels are involved as in gas atoms. This is a definite proof that the $4f$ shell is well protected by the external electrons and is little disturbed by the forces which cause the complete rearrangement of the levels of the valency electrons.

The investigations of D. S. Rojdestvensky on anomalous dispersion enabled him to give the first quantitative method of measuring the relative intensities of serial lines and to establish the first quantitative relationships for these intensities in alkaline metals. These investigations started another important line of research in the Optical Institute. The interpretation of the results of these investigations varied to some extent in conformity with the modifications of the theory, but they always provided an essential characteristic of the energy levels of the absorbing atom. Work in this direction was extended to the group of alkaline earth metals by V. K. Prokofiev and his co-workers. Prokofiev and Filippov and later Filippov alone, investigated the ultraviolet region of the spectrum. For this purpose they used the the fluorite interferometer devised by D. S. Rojdestvensky. From its foundation up to the present day the State Optical Institute has played a leading part in research on anomalous dispersion. The workers of the State Optical Institute have determined the fundamental constants characterizing the transition probabilities in atoms, which are cited in all textbooks. With investigations on anomalous dispersion are closely connected the first measurements by A. N. Filippov of the intensity of emission lines. To the same group of works belong the first investigations of M. L. Veingerov (begun under A. A. Lebedev) on the magnetic rotation in alkaline vapours and the natural breadth of the lines.

Alongside with the experimental study of the properties of electronic shells much theoretical work in this direction was done in the Optical Institute. Such are the works of V. A. Fock and his co-workers devoted mainly to the elaboration of approximate methods for the calculation of complex atoms. The methods of Hylleraas and afterwards Hartree (the latter was formerly used in the Optical Institute) were not rigorous enough because they did not consider one of the most important factors of the bond, the exchange forces, and consequently could not provide exact results. V. A. Fock worked out a method of generalized self-consistent field, which had neither of these defects. Fock's method was then applied to the theory of the nucleus (Heisenberg) and the theory of metals (I. E. Tamm). The energy levels and the relative intensities of Na, Li and Al^{++} were calculated by this method. The decisive triumph of Fock's theory was the comparison of the calculated intensities in lithium lines with the

results of Filippov's anomalous dispersion measurements. The lithium spectrum shows an anomaly: the third doublet is brighter than the second, and this can be explained only by the exchange forces, which are taken into account in Fock's theory. On the basis of this theory of the symmetry of the hydrogen atom and by an analysis of the Schrödinger equation in momentum space. Fock developed another method for the approximate calculation of atoms with closed shells. This method is very elegant and simple, and by it one can obtain exact results five or six times as quickly as before.

The development of the theory of atomic spectra led to the revival of emission spectral analysis invented long ago and abandoned because of insurmountable theoretical difficulties. This work was also begun in the USSR.

It was carried out with much energy and in close contact with industry by G. S. Landsberg, S. L. Mandelstam and others at the Physical Institute of the Moscow State University. They have also worked out the method and procedure of spectral analysis (chiefly for ferrous metals) and designed several instruments for this purpose (steeloscope, steelometer). In the Optical Institute this work also was carried out on a large scale. The presence of platinum and gallium in sulphide ores was studied, jointly by A. N. Filippov and the Platinum Institute of the Academy of Sciences. The sources of the raw materials for the extraction of caesium and rubidium were indicated (Filippov) and a sensitive method of analysing them given (I. M. Tolmachov). A method of analysing tin ores was developed and applied (V. K. Prokofiev and his co-workers). Two original spectrographs for spectral analysis were designed and several series were built (Prokofiev). The workers of the Optical Institute have applied spectral analysis in many expeditions in search of mineral ores. At present emission spectral analysis is used in many places in the USSR for very different purposes.

A gas discharge in a tube is much more economical than an incandescent lamp; but the difficulties encountered in obtaining white light prevent the application of gas discharge lamps for general lighting purposes. White light is generally produced by the luminescence of a mixture of gases. Extensive work connected with parallel study of optical and electrical characteristics in gas-filled lamps (chiefly with mercury and cadmium) was carried out in the laboratory of the Electrotechnical Institute of the Union by V. A. Fabrikant and others. In order to elucidate the part played by collisions of the second kind S. E. Frisch and A. A. Ferchmin (Optical Institute) studied the luminescence of a mixture of sodium and mercury vapours. In the course of this study they found new properties of the excitation functions.

The difficulties of studying the properties of electron systems from their spectra rapidly increase with the number of nuclei. Even in diatomic molecules it is very difficult to divide the electrons in groups determining the properties of the system and no general principle determining the formation of electronic shells in molecules, analogous to the Pauli principle for atoms, has yet been found. Theoretically the question is clear only for the hydrogen molecule, which has but two electrons. For the calculation of more complicated molecules a new approximative method was proposed by H. H. Hellmann (Moscow, Karpov Institute). The exchange forces of the external and internal electrons were replaced by a fictitious repulsion force between electrons and nucleus.

Two attempts to describe the electronic shell of diatomic molecules were made in the Optical Institute. In the first of these (dissertation of M. G. Wesselov, carried out under V. A. Fock) the Thomas-Fermi method was used to calculate the charge distribution of the internal electrons and the Heitler-London method to that of the valency electrons. The potential energy of the nuclei as a function of their mutual distance was computed. The calculation when applied to the molecule Li_2 gave too small a value for the bond energy, but there is reason to believe that on replacing the Heitler-London method by a more perfect one it will be possible to obtain rough quantitative results. The second attempt consisted in looking for essential criteria for dividing the electrons of homopolar molecules into shells (V. M. Tschulanovsky). It was made on the basis of extensive experimental material and it

was possible to establish for many molecular states quite definite electronic configurations, in other cases the arbitrariness in the electronic configurations was considerably limited.

It is difficult to estimate the strength of the electronic bond in the molecule because serial regularity, which so much facilitates the analysis of atomic spectra, is here almost always absent. The difficulty which prevents the solution of the fundamental problem of molecular spectroscopy, *viz.*, the exact determination of the dissociation energy of normal and excited molecules into atoms and the correlation of the molecular levels with definite products of disintegration, is the lack of definite knowledge of the true law of interaction between the nuclei as a function of their mutual distance. Hence the necessity of great accuracy in molecular spectroscopy, taking into account all the numerous perturbations of terms connected with the interaction of individual electron states. Two new kinds of perturbations of electronic levels were discovered in the Optical Institute (V. M. Tschulanovsky) and a complicated case of mutual perturbation of three levels was analysed (Tschulanovsky and B. I. Stepanov). The work was carried out on molecules of N_2 and CO in the vacuum region, which is particularly important for the study of molecular spectra. For this purpose precision vacuum spectrographs were constructed and the entire technique of work in the vacuum region was revised (Tschulanovsky).

A series of works (N. V. Kremenevski) was devoted to elucidating the type of bond in molecules of mercury, thallium and lead.

Induced pre-dissociation offers more opportunities for studying the energy levels of the molecule. With the increasing vapour pressure (of the substance itself or of its admixtures) the forbidden states may be resolved and hitherto independent levels may begin to be mutually disturbed. V. N. Kondratiev and his co-workers (Institute of Chemical Physics, Leningrad) studied the phenomenon of induced pre-dissociation in diatomic molecules of iodine, bromine, tellurium and sulphur.

It is only recently that the state of theory permitted a detailed study of the electronic shells of molecules. Before that more general questions were treated concerning the type of the molecular bond and the optical methods of determining the heat of dissociation. Here we come to a number of works of K. V. Butkov and his co-workers, mainly concerning the spectra of monoatomic and triatomic haloid compounds (State Optical Institute and Leningrad State University). The rotational-vibrational structure of the spectra of complex molecules was treated theoretically in a series of papers by M. A. Eliashevich (State Optical Institute). In the infra-red region Veingerov investigated the absorption spectra of liquid bromine and solid red phosphorus. The interest of the research lies in the fact that the absorption in this case was due to electrically asymmetrical formations of identical atoms.

The method of optical excitation proved to be a powerful instrument for studying the disintegration of molecules and bringing about this disintegration. In this field the Optical Institute beyond doubt plays a very important role owing to the extensive work performed by Terenin and his co-workers. The works of this group of physicists are well known: an account of them has been given more than once and I shall restrict myself to a brief recapitulation of the main lines.

In 1925-1932 the photodissociation of salt vapours was studied by the luminescence of the atoms or the radicals formed after the disintegration of the molecules of the salts.

1931-1936. Investigations on the kinetics of the interaction of excited atoms and radicals with other molecules.

1934-1937. Investigations on the fluorescence of aromatic compounds in the gaseous state with a view to elucidating the mechanism of the transfer of electronic energy from one part of the molecule to another.

As a result of this work, new methods of investigation were developed and a number of elementary processes which govern the course of the reaction were made clear.

The work of Y. I. Larionov should be noted on the disintegration into three atoms simultaneously

of the salts $TeCl_2$ and $TeBr_2$ under the action of light, and, as referring to the same field, the work of V. N. Kondratiev (Institute of Chemical Physics, Leningrad) on the spectral investigation of chemical processes and the well-known work of Kondratiev and A. I. Leipunsky on the recombination luminescence of iodine.

A strong external action applied to the electronic system (electron impact, the impinging of a suitable photon, chemical action of another such system) is generally followed by the radiation of light from the disturbed system; the light radiated in this case is characteristic of the structure of the system itself and of the processes which take place therein. The latter circumstance is especially important in studying complex molecules placed in an interacting medium. This vast region of luminescence includes fluorescence, phosphorescence, chemical luminescence, etc. All these questions were dealt with in the long series of investigations performed by S. I. Wavilow and his co-workers. This work was begun at the Moscow University and has been continued since 1932 in the Optical Institute.

Here also the Optical Institute played a leading part, and the scope of the work and the abundance of results makes it impossible to mention here more than the most important of them.

The study of fluorescence quenching in solution by extraneous substances is theoretically and experimentally almost completed.

It has been discovered and traced far into the ultraviolet region that the polarization of the fluorescence light changes in magnitude and sign in a very sharp and strange manner with the wave length. This effect is evidently very characteristic of the processes occurring in a radiating molecule, but hitherto it has been explained only in part.

Abundant experimental material has been collected and many regularities discovered for the case of concentration quenching.

Further experimental and theoretical work in this direction is in progress.

It has been shown by a great amount of experimental material (S. I. Wavilow and A. A. Shishlovski) that in the overwhelming majority of cases the fluorescent substance emits two kinds of luminescense very different in duration (10^{-9} and 10^{-4} seconds).

Levshin (Physical Institute of the Academy of Sciences) discovered the so-called law of mirror similitude in the frequency scale of absorption and fluorescence spectra.

The character of the luminescence (colour and duration) can be used not only for studying the processes taking place in the substance but simply for sorting. Thus in Optical Institute very simple sorting methods were developed for mixed optical glasses, for detecting infections of the grain, etc. The luminescence analysis, which has been developing in a casual way (rarely in the hands of physicists) in different places, chiefly abroad, was radically changed and improved in the laboratory of S. I. Wavilow. This was achieved firstly by more efficient illumination of the sample (by a spark) and secondly by combining the fluorescence method with the phosphorescence method.

Another practical application of the work on luminescence was found in the study of the luminescence in the terrestrial atmosphere. The work has been carried on for several years by several collaborators of the Optical Institute in expeditions to Mt. Elbruz and in two ascents to the stratosphere (I. A. Khvostikov). Much data was collected characteristic of the scattering of light in the earth's atmosphere and of the photochemical reactions which take place therein. There were observed (I. A. Khvostikov) some peculiarities in the polarization of light approximately at the height of the Heaviside layer which seems to indicate a possibility of using the optical method to study its structure.

All these new data on luminescence necessitated the elaboration of new methods. In this respect the method based on the threshold of visual perception devised by S. I. Wavilow is of particular interest, the most sensitive method for recording faint luminescence. (In the blue-green region of the spectrum the eye perceives light if it has received only a few photons in about 0.1 second). Several types of spectrographs of high luminosity were constructed (G. G. Slusarev) for

the work on luminescence; I shall mention only one with a luminosity 1:0.5 (for the visible and ultraviolet region), which is probably almost the limit of what may be achieved.

The work on the scattering of light, begun long ago, led in 1928 to the discovery of the so-called combined scattering (Raman effect). Simultaneously with and independently of Raman this phenomenon was discovered in crystals of quartz and iceland spar by Landsberg and Mandelstam (Moscow State University). In a series of investigations Landsberg and Mandelstam studied the essential properties of the spectra of the scattered light: the relative intensities of the combination lines on the short and long wavelength side of the Rayleigh line, their state of polarization, etc. E. F. Gross (Optical Institute) discovered experimentally a very subtle phenomenon, the scattering of light in elastic stationary waves in crystals. This phenomenon was foretold long before it was actually observed. The elements of its theory were given by Brillouin (1922) and Mandelstam (1926). Further theoretical development is due to Mandelstam, Landsberg and Leontowich and to I. E. Tamm (Moscow State versity).

Further work on the scattering of light (E. F. Gross and his co-workers) in State Optical Institute was devoted to the investigation in liquids and crystals of the region near the unshifted Rayleigh line. The "wings" near the Rayleigh line, observed in the spectrum of light scattered in liquids, were formerly usually explained by the rotation of the molecules of the liquid. E. F. Gross and M. F. Vuks proved the impossibility of such an explanation. New lines, very near to the Rayleigh line, were discovered in single crystal in place of the wings. The wings in the liquid must be ascribed to the incomplete vanishing of crystalline properties on melting. The near lines in the single crystal were ascribed not to the intramolecular oscillations but to those of the crystal lattice. This was definitely proved by M. F. Vuks in the course of further research. Identical crystal lattices built up of different molecules were found to have similar "low frequency" spectra; in the same substance these spectra change radically with the change in the modification of the crystal (produced by change in T) which leaves unchanged the structure of the molecule. The study of the low frequency spectra affords a new method for studying the internal properties of the solid and the liquid phase.

E. F. Gross and M. F. Romanova first observed combination scattering in amorphous bodies (in fused quartz and flint, in SiO_2 molecules).

To elucidate the binding forces between the molecules of a crystal lattice the investigation of the absorption spectra of crystals at very low temperatures is of great interest. Such investigations have been carried on for many years in the laboratory of I. V. Obreimow at the Ukrainian Physicotechnical Institute (I. V. Obreimow and A. F. Prikhotko).

The absorption spectra of naphthalene, phenanthrene, anthracene, etc. as well as oxygen proved to be characteristic for the molecule (rather conspicuous recurrence of a series of more or less displaced bands of free molecules) and for the crystal lattice.

The investigations of crystalline oxygen made it possible, owing to the simplicity of the molecule, not only to ascertain the analogy with the spectrum of gaseous oxygen but also to assign to the electronic levels in the crystal a definite spectroscopic symbol characterizing the electron configuration of the molecular shell. It was also found that the different configurations of crystalline oxygen showed very marked differences. The experimental technique in dealing with crystals at very low temperatures is very specialized and difficult.

Closely related with these investigations is the work of T. P. Kravets and M. V. Savostianova (State Optical Institute) on a very specialized but exremely important subject, the formation of the latent image in the photolayer. It was shown that it was always attended by the formation in the photolayer under the action of light of small colloidal particles of silver but not atomic, as was thought previously.

All these investigations cover the field of quantum interaction between light and matter

if not completely, nearly always with great profundity and efficiency.

I shall further mention some very important methods and instruments devised in the Optical Institute.

D. S. Rojdestvensky gave a simple and efficient method for determining the resolving power of spectroscopic apparatus and a new, more correct theory of resolving power. A new system of spectral standards of the second order is nearly completed (G. V. Pokrovski). The technique of the work in the infra-red region has made considerable progress (M. L. Veingerov). Veingerov created new supersensitive energy indicators in the infra-red region, based on the principle of two-layer films and of the gas thermometer. E. M. Brumberg created a series of new instruments for the monochromatization of light, the study of its polarization, etc.

It appears from what has been said that nearly all the work in the field of quantum interaction between light and matter was devoted to the study of the properties of matter by optical methods. Much less was done to study the interaction between the light and elementary particles and to determine the elementary properties of the photon.

The fundamental theory of the interaction of light with the electron was advanced by Dirac. In a series of papers V. A. Fock developed and simplified it. In its present form quantum electrodynamics, notwithstanding several substantial defects, is a complete theory embracing quantum mechanics in the narrow sense of the word as well as the interaction of material particles with light.

Cherenkov (S. I. Wavilow's laboratory in the Physical Institute of the Academy of Sciences) discovered a new phenomenon, the one sided radiation of ultraswift electrons. This phenomenon was explained on the basis of classical electrodynamics by I. M. Frank and I. E. Tamm.

In conclusion we must mention the experiments of S.I. Wavilow on the properties of the photon. It has been said above that the human eye receives an optical sensation if it receives simultaneously (within about 0.1 sec) a few photons. It produces an impression of flash. Simultaneous observation of the two beams in the interferometer before their fusion showed that the flashes do not occur simultaneously in both fields. Thus the classical conception of the interference of two independent flows of energy is ruled out. The different quanta, as was supposed by Dirac, are not actually coherent. In the interference field the entire system of interference bands never flashes up simultaneously: the flash appears now on one light band and then on the other, but never on a dark one, *i.e.*, a certain distribution exists of the probabilities for the quanta to appear at a definite spot. In every elementary act the photon behaves like a particle.

In this survey I have cited only the most essential directions of optical research in the USSR, almost exclusively in the field of the application of optical methods to the study of the structure of matter. But it is clear even from this brief survey that the state of optics in pre-Revolutionary Russia cannot be compared to its present state. This equally refers to the scope of research and the amount of scientific, technical and organizational experience accumulated and to the importance of scientific research in this country. Broad perspectives have opened for scientific research and science is developing successfully in close contact with industry.

This is one of the achievements of the Great October Revolution and there is every reason to suppose that the tremendous tasks lying before Soviet scientists in introducing into industry their scientific achievements and of attaining new heights of knowledge will be fulfilled.

Vitamin C and Disease

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VITAMIN C was associated so long with scurvy, and it was hence called antiscorbutic vitamin. Recently it has been established that the question of vitamin C is related to many other diseases. We are giving here a review of the role of vita C in various diseases.

Latent Scurvy

Manifest scurvy is very rare nowadays. Those who consume less than adequate amounts of vitamin C show a state of ill-health. They get tired very easily, complain of loss of energy and pain in the joints and limbs. They show a shallow, muddy complexion and diminished capillary resistance. If a small area of the skin is subjected to a controlled degree of suction applied for a definite length of time small cutaneous haemorrhage appears. Most of these cases promptly respond to vitamin C intake.

Vitamin C and Infection

Indications exist that vitamin C plays an important part in protecting the system against certain infectious agents or their toxins. Jungleblut and his co-workers have shown that the virus of anterior poliomyelitis and diphtheria toxin are inactivated by ascorbic acid. J. Kinger and W. Bernkope showed that vaccinia virus is also inactivated by vitamin C *in vitro*. Vitamin C reduces the toxicity and virulence of the whooping cough bacillus *in vitro*. *Pneumococcus, Staphylococcus, B. Coli, B. typhosus, B. enteritidis, haemolytic streptococcus* also are inactivated *in vitro*. Guha and Ghosh have also observed the inactivating effect of vitamic C and also of glutathione and cysteine on diptheria and tetanus toxins. Guha and Das Gupta have found that ascorbic acid has an inhibitory effect on the growth of certain bacteria in synthetic media, while it has a stimulating effect on certain fungi.

Guineapigs on scorbutic diets are less resistant to diphtheria toxin than normal controls. Further, it has been siated that administration of vitamin C to normal guineapigs increases their resistance to the toxin. Bamberge and Zell of Hamburg have reported better results in children suffering from malignant diphtheria by giving vitamin C and cortin in addition to antitoxic sera. Cortin or vitamin C alone is not so useful. It has been reported however, that cases of diphtheria receiving 500 units of antitoxin per kilogram of body weight with or without the addition of 500-700 mg. cebion (a preparation of vitamin C) daily show no difference in the course of the disease. Najib Farah has treaied cases of enteric fever by intravenous injection of suprarenal cortex extract and vitamin C. Immediate improvement followed without untoward reactions.

McConky and Smith fed tuberculous sputum to guineapigs suffering from hypovitaminosis C and to animals on a normal diet. Ulcerations of the intestine developed only in deficient animals.

Vitamin C in these diseases is useful only in prophylaxis of the disease. Whether it can cure the disease is questioned.

Desensitizing Properties of Vitamin C

Dainow showed that ascorbic acid has a beneficial action on certain allergic conditions of the skin.

In cases of intolerance to arsenical injections intravenous administration of vitamin C desensitizes the patient within 24 hours. Patients of exfoliative arsenical dermatitis recover when vitamin C is administered intravenously. Dainow reports several cases of Herpes Zoster and Herpes

simplex which are improved if vitamin C is administered early.

Vitamin C in Heart Failure

Abbasy reports that vitamin C has got diuretic properties. He administered vitamin C to children suffering or convalescing from rheumatism. When these patients were saturated with vitamin C they showed increase in the quantity of 24 hours' output of urine. Vitamin C having no deleterious effect on kidneys is therefore a very useful diuretic. This observation of Abbasy led William Evans to use vitamin C in heart failure. He thought that as vitamin C causes diuresis in rheumatic cases in which there is no oedema, it may prove useful in case of heart failure with anasarca. He found that the diuretic effect of vitamin C is greater than that of digitalis and, in some cases, than that of diuretin and theobromine. The condition of the heart, however, is not improved .

Haemorrhagic States

In every class of haemorrhagic diathesis, it is claimed that intravenous injection of vitamin C helps to arrest haemorrhage. Severe uterine haemorrhages are also found to be arrested after vitamin C administration. But it is not certain whether these conditions are only due to lack of vitamin C. Some other factors may be associated with it, *e.g.*, vitamin P of Szent György which is associated with capillary permeability or vitamin K which increases blood clotting.

Vitamin C and Anaemia

Anaemia is some[illegible]es observed as a result of inadequate intake [illegible] vitamin C. It is said to assist like iron, copper, thyroxin the transformation of normoblast to erythrocyte. Parson has reported cases of [illegible]rthochromic normocytic anaemia, normocytic [illegible]nd slightly hypochromic anaemia and macrocytic anaemia, all of which were cured by vitamin C a[illegible]inistration. But in some severe cases of scurvy there are no signs of anaemia. This is very difficult to explain. It is suggested that under certain conditions the bone marrow suffers more damage than under others.

Cataract

Deficiency of vitamin C is suggested to be an etiological factor in the onset of senile cataract. Blood contains 9 mg. , aqueous humor 20 mg.% and lens 30 mg.% of vitamin C. The higher concentration is due to diffusion of vitamin C from blood into aqueous humour and from the latter into the lens. The reverse process is impossible. But in old age and in uveitis permeability of the barrier is increased, and the vitamin C content of the lens and aqueous humour diminishes. Lens being devoid of blood supply, vitamin C plays the main role in the oxidation reduction system of the lens. The vitamin C content of the lens being nil, tissue respiration, it has been suggested, cannot take place and opacity results.

In guineapigs on scorbutic diet some show opacity in the lens and in others, which have transparent lens, if the anterior chamber is perforated so that aqueous humour is drawn out, opacity of the lens results. During the last three weeks of pregnancy if the guineapigs are kept on scorbutic diet they give birth to young, which have congenital lenticular opacities. Cataract is found to be common among poor people. These facts suggest that vitamin C might play a part in the onset of cataract.

Vitamin C and the Healing of Fractures

It has been noted that in sailors suffering from scurvy ulcers or wounds that had healed long ago recurred and fractures which were untied redissolved. All investigators are in agreement that vitamin C deficiency is a very strong factor in the retardation or prevention of the healing of a fracture. Vitamin C deficiency inhibits the traumatic inflammatory reaction which introduces the process of fracture healing; it also inhibits the power of the non differential connective tissue to differentiate into osteoblastoma; and finally it inhibits the production of collagen.

Vitamin C and Teeth

Cases of dental caries, inflamed gums and pyorrhoea alveolaris are mainly due to deficient intake of vitamin C. To administration of pints of orange juice a day these cases respond remark-

ably. Decay of tooth is arrested, condition of the gum is improved, and loose teeth get tightened.

Vitamin C and Glycosuria

Vitamin C is found to reduce the glycosuria if taken generously or if given in the pure form, as Roller has found.

Vitamin C and Morbid Pigmentation

Adrenal gland is a storehouse of vitamin C. In Addisson's disease in which there is degeneration of the adrenal gland there is found a characteristic pigmentation. This is due to non-transformation of dioxyphenylalanine, a precursor of melanin, into adrenalin by the adrenal gland. It is therefore suggested that vitamin C prevents the formation of melanin. Schade has measured the degree of pigmentation provoked by light in two series of cases, in one of which vitamin C was given by the mouth and by intravenous injection while the other series was not thus treated. It was found that the resulting pigmentation was comparatively slight in the vitamin C treated series. Marked pigmentation of the skin is sometimes associated with scurvy. H. Hoff states that the natives of Schleswig-Holstein practised in their youth the eating of lemons to cultivate a pale complexion which at that time was very fashionable. These natives stumbled empirically on a process for which there is today a scientific explanation.

Vitamin C and Peptic Ulcer

Harris and his colleagues have seen that patients suffering from gastric and duodenal ulcer show diminished vitamin C output. Recently it has been shown that peptic ulcer is associated with vitamin C deficiency. At St. Bartholomew's Hospital it has been seen that in patients suffering from peptic ulcer who died after operation there is no deposit of any fibrous material along the suture line.

Rheumatism and Tuberculosis

Rhinehart and his co-worker held the view that rheumatic fever results from a combined influence of vitamin C deficiency and infection. They injected various strains of Beta streptococci and other organisms into guineapigs. In cases of adequate vitamin C nutrition rheumatic lesions were not observed but when superimposed on vitamin C deficiency the infection produced valvulitis. Sendroy and Schultz state that vitamin C hypovitaminosis is the result and not the cause of rheumatic fever. They repeated Rhinehart's experiment and the results obtained are not similar to rheumatic infection. Further, administration of vitamin C does not improve these patients. Abbasy, Harris and Ray have shown that there is diminished excretion of vitamin C in rheumatic fever and in active tuberculosis. And they require large doses for a long time to undergo saturation with vitamin C. This has been questioned by Person (*Lancet, I*, 70, 1938). He observed that some of the active or convalescing rheumatics show more excretion of vitamin C than controls. The majority of children with acute rheumatism excreted more than the infection control group and the majority of rheumatic convalescent children excreted more than the convalescent controls. With regard to saturation 61 per cent of the non-infectious hospital control children were saturated after the first test dose of 500 mg. of ascorbic acid, while of children with acute rheumatism fifty per cent were saturated after the first dose. The diminished output of vitamin C of Harris *et al* may perhaps be explained on the following considerations. It is seen that alkalies diminish and acids increase the output of ascorbic acid in urine. Further, sodium salicylate also diminishes the vitamin C output in urine. Harris *et al* have not mentioned whether their patients were taking salicylate or alkalies at the time of the test.

The above review would indicate that what was considered to be the anti-scorbutic vitamin is related to numerous physiological and pathological conditions. These advances have been possible owing to the remarkable achievement of Szent-Györgyi, who identified the vitamin and succeeded in preparing it in large quantities.*

* From a paper read at the Calcutta University Chemical Club on 23rd March, 1938.

The Ninth International Congress of Philosophy

THE Ninth International Congress of Philosophy was held in Paris during the first week of August with Prof. Henri Bergson as its Honorary President to commemorate the tercentenary of the publication of the *Discours de la Méthode* (published in 1637) of Descartes, which, as we all know, had made an important landmark in the history of European philosophy since the days of Aristotle.

The session was solemnly opened on the 31st of July, 1937, at the famous amphitheatre of the Sorbonne by M. Jean Zay, Minister for National Education and Fine Arts, in presence of the President of the Republic. Nearly 300 representatives from the different intellectual centres of the world assembled there to pay homage to the illustrious " father of modern philosophy."

It will be difficult to give in the compass of so short an article like this, a complete survey of the works done in this great gathering of philosophers. We shall, therefore, confine ourselves at present to some of the principal items of the Congress.

Any homage to this great thinker would remain inadequate if certain sections were not devoted to the discussion of the influence of Descartes and other Cartesians. Thanks are, however, due to the Organizing Committee of which Prof. E. Bréhier is the President, for devoting one section exclusively to the Cartesian doctrines. Due attention was also paid to the other branches of philosophical studies that, in some way or other, owed inspiration to Descartes, *viz*: –Philosophy of Science and Epistemology, (the Method and the Methods, Logic and Mathematics, Causality and Determinism), Reflexive Analysis, and Transcendence, and last but not the least, the Value, the Norm and Reality.

As the philosophical bearings of relativity were the favourite theme for discussion on previous occasions, the examination of the present position of determinism and indeterminism occupied a very important place in this Congress. Prof. Louis de Broglie, the eminent French physicist, in course of a highly interesting communication entitled: " Reflexions on Indeterminism in Quantum Physics " (VII 3) dwelt on the significance of indeterminism as revealed by the principles of quantum physics. For him, determinism denotes only the *prévisibilité rigoureuse des phénomènes* (prevision of phenomena). But the quantum physics has brought forth within recent years innumerable instances where deterministic laws, far from being satisfactory, fail to supply us with adequate explanation. Modern physics, according to him, is not yet prepared to give any verdict whatsoever in its favour although he is not at all a sceptic as to its acceptance by the physicists in the long run. It was a singular event that the advocates of indeterminism found in Lord Samuel too strong an opponent to convince with their facts. The celebrated British philosopher in an illuminating paper on " The Analysis of Indeterminism " (VII 21) has collected and co-ordinated a large number of statements from the works of eminent scientists like Einstein, Max Planck, and Lord Rutherford only to show that determinism is perfectly logical and still holds good in modern physics, an opinion also in full agreement with that of M. Marcel Barzin (VII 15, *Probabilité et Déterminisme*).

The philosophical implications of modern exact sciences were also the subject of several important communications in the section of " Logic and Mathematics." In an excellent paper on " The Relation between the Principle of Uncertainty of Heisenberg and the Logic " (VI 88) Miss Paulette

Février has shown how far the statistical laws have necessitated the addition of new chapters to the classical Logic. Interesting papers were also communicated on Logical Calculus, Intuitionism and Formalism in Logic. The neo-positivistic school of Vienna, it may be noted, did not receive any favourable support from the metaphysicians. The following papers dealing with these problems should be mentioned in this connection: Alfred Tarski Sur la méthode déductive, (VI 95); Alfred Errera Sur les démonstrations de Non-Contradiction, (VI. 127); E. W. Beth—L'Evidence intuitive dans les Mathematiques modernes, (VI. 161). This account will remain incomplete if a reference is not made of two highly interesting papers discussing the important part played by the Analytical Geometry of Descartes in the development of modern geometry, (Elié Cartan—Le rôle de la Géometrie analytique dans l 'Evolution de la Géometrie, VI. 117. B. de Keaékjatro La Méthode de Descartes et la Géometrie moderne, VI. 166).

In the domain of metaphysics proper the discussions on such controversial but fascinating topics as transcendence, immanence, and value have shown beyond doubt the most prolific nature of contemporary philosophy. Almost all the principal metaphysical schools were conspicuously represented in the Congress. It will not be out of place to mention in this connexion the interesting debate held between the two eminent metaphysicians: Prof. L. Brunschvieg and M. Gabriel Marcel on Transcendence which created a considerable interest amongst the delegates.

The Idealistic Movement has, from some time past, come into lime-light in France amongst which the place of Prof. Brunschvieg is no doubt a very prominent and important one. His idealism at once differs from that of Hegel in that it is more reflexive, more analytical, and more critical. His paper on "Transcendence and Immanence" in which he has set forth his views on these two interesting topics of metaphysics is certainly a welcome addition to his excellent series of works on Idealism. Nor are we to forget to mention here the other important currents in modern thought, namely, the phenomenological school that has recently come into existence in Germany. The prominent exponents of it are Brentano, Husserl, Max Scheler and the Existential school advocated by Nicolas Berdiaeff (Russia), Gabriel Marcel (France), and Heidegger (Germany), to select a prominent few out of the large number of its adherents.

A word about the 'critical realism,' a term assigned by M. Maritain to the system of thought recently revived by him out of the Scholastic philosophy of Saint Thomas d'Aquinas. This revival of the philosophy of Being, hitherto so little followed and encouraged, has received welcome reception from many distinguished philosophers amongst which the names of Prof. E. Gilson, M. R. P. Sertillanges, M. Maurice Blondel, and Louis Laville, deserve mention.

These are, in short, some of the broad issues on which the communications were read and discussed. As the proceedings were published during Congress session, it was found to be extremely useful in following the discussions held in so many languages. For the perfect management of the Congress credit is however due to its president, Prof. Bréhier and to its secretary, M. Raymond Bayer, a promising young aesthetician.

It will be failing in our duty if the Western philosophers and especially the French philosophers do not take the opportunity of extending their heartfelt felicitations to their Eastern colleagues who took part in the Congress and contributed much to its success. Does it not sufficiently indicate that the distance in space, instead of being a positive hindrance, leads always to the unity in the realm of thought?

Olivier Lacombe.

Notes and News

Indian Chamber of Commerce's Views on the Proposed Recruitment Scheme

Some time ago the Government of India addressed a letter to all Provincial Governments for eliciting their opinion, in which they proposed a suitable scheme for recruitment in future of all Government servants. By this, the Government think of minimizing middle class unemployment in this country, and we expressed our doubts as to the feasibility of the scheme (*vide* SCIENCE AND CULTURE, March, 1938, p. 484). Recently the Committee of Indian Chamber of Commerce, Calcutta, in course of a communication addressed to the Government of Bengal, state that this proposal of the Central Government will not have an appreciable effect on the question of middle class unemployment which it seeks to remedy. The Committee are of opinion that the objects underlying the proposed scheme, namely reduction in the number of young men seeking Government employment, will not be achieved by the mere addition of another examination involving elaborate organization and consequent public expenditure. The Committee are right in pointing out that, as no satisfactory method could be devised for restricting admission for the proposed competitive test, the number of diplomas offered would be nearly twice the number of the probable annual requirements of officials, thus defeating the object of the scheme. The Committee do not also think that the examination as suggested can be operative for higher appointments and technical posts. The Committee point out that a young boy might fail in the Government Diploma examination at the age of 17, but might later pass creditably an Engineering or Accountancy or other technical examination which would under the existing system qualify him for a suitable Government post. It would, therefore, be unfair to disqualify him for such a post on the ground of his having failed at diploma examination which would of course be a general nature and is obviously not meant for higher or technical posts. The Committee further point out that the proposed diploma or pass would merely involve an unnecessary duplication of examination like that of School Leaving Certificate which exists in some of the Indian Universities. They therefore observe that the scheme which provides for the addition of another examination for those seeking entrance to Government service can hardly go far in the solution of the fundamental problem of middle class unemployment. However, owing to the reduction in the scale of salaries as well as a growing industrialization of the country, the attitude of qualified young men towards Government appointment has, in the opinion of the Committee, been gradually changing. The Committee, therefore, emphasize the necessity of a healthy and all round economic development of the country which only can tend to relieve the large volume of unemployment and can provide an alternative source for absorption of middleclass talent. We entirely agree with the views of the Committee of the Indian Chamber of Commerce.

Earthquakes in India in 1937

During 1937 there were 82 perceptible earthquake shocks felt in India. Regionally considered, the shocks were distributed as follows: Burma 28; North-Eastern India (including Sikkim, Nepal and Tibet) 31; North Western India (including Kashmir, Chitral and Baluchistan)– 21; and Peninsular India 2. All these shocks were of slight intensity, unattended with any damage to buildings or persons, with the solitary exception of rather the severe shock of the 14th November, which affected a considerable tract of North West India and which was felt at such distant places as Kabul, Dehra Dun, Simla, Multan, Dera Ismail Khan, and Rorkee, though its epicentre, as deduced from observers' reports and from seismic records available from the meteorological observatories at Bombay, Agra, Calcutta and Kodaikanal, was located in the Hindu-Kush Mountains, northwest of Drosh in Chitral. Frequency of the aftershocks of the Quetta Earth-

quake of May 1935, according to the Geological Survey of India, appears to be considerably diminished, but several sharp shocks were felt during the year in the Assam seismic area, including those of the 16th January at about 18.45 hours and of the 21st March at 21.45 hours I.S.T.

Bihar Conference for Improvement of Agriculture

The Province of Bihar possesses at present no agricultural college- the one that it had having been closed down a few years ago. In a Conference of officials and non-officials held at Patna on May 1 last, to discuss ways and means as how best to utilize the agriculture department in the most effective manner for the improvement of agriculture in the Province, a resolution was passed urging on the Government to re-open the college for training in agriculture - not later than June 1, 1939. Another resolution stated that the funds allotted to the Department of Agriculture of the Province were inadequate for demonstration work and should therefore be increased. The necessity of making available to the cultivator improved seeds, manures, implements and short-term loans on nominal rates of interest was stressed by the Conference which expressed the opinion that the Government should take early steps to utilize the Land Improvement Loans Act on a much wider scale than has been done in the past for permanent land improvements. The Conference finally discussed the aims and objects of the Government experimental farms and suggestions were made for their better utilization in the work of agricultural improvement of the Province and possibility of running demonstration farms on a commercial basis.

Bengal Government's Proposed Conference on Irrigation

We have on several occasions in the past dwelt on the problem of irrigation especially in Bengal, which has, it is admitted on all hands, grown really very acute. We also stressed on the urgency and importance of calling a conference of experts and specialists (scientists and engineers) and also eminent public men, with the object of discussing ways and means to develop the irrigation policy of the Government. We have, from time to time, described in these columns what is done in other advanced countries, *e.g.*, Germany U.S.S.R., etc., and suggested what can be done to improve irrigation in India. The reader may in this connexion be referred to Prof. M. N. Saha's article in the *Sir P. C. Ray Commemoration Volume*, on the 'Need for a Hydraulic Research Laboratory in Bengal' and SCIENCE AND CULTURE *1*, 5-11, 1935; 165-167 and 219-29, 1935; *2*, 281-86, 1936. It is now reported in the Press that the Government of Bengal contemplate convening a small conference of leading scientists and engineers in this connexion. It is understood that the Irrigation Department of the Government of Bengal have circulated a questionnaire with a note and a copy of the paper on "River Problems in Bengal" by Mr S. C. Majumder, Chief Engineer, Irrigation Department, Bengal. The intention of the Government is to adopt a forward policy, but before definitely deciding the policy to be followed, the Government wish to ascertain public opinion on the point. The questionnaire has been based more or less on the broad aspects of the irrigation problem in the province and their solution as discussed in Mr Majumder's papers. The questions asked are with reference to artificial irrigation, health and productivity of the soil, embankments, restoration of the Ganges spill, waterways and navigations. The replies received will form the basis of the discussion of the Conference. We await with great interest its outcome, and hope that the Government will give effect to the recommendations of the Conference, soon after they are made.

Dr R. B. Lal on India's Population

Since the last census, it has been often given out that the increase in the rate of India's population is more rapid than the means of subsistence- that she is heading not only towards a population record of 400 millions in 1941, but perhaps also towards a crisis . An altogether gloomy picture has been generally drawn by the population experts. But is the situation really as serious as it has been declared? Dr R. B. Lal, Director of the All-India Institute of Hygiene and Public Health, Calcutta, addressing, as its chairman, the Vital Statistics Section of the All-India Population and Family Hygienic Conference held in Bombay in April last, presented a more hopeful picture. His view was that most countries had witnessed, and had adjusted themselves to,

sudden increase in population. The role of science and social effort was to bring about a balance between the population and amenities of life available at one particular moment. Besides, India's resources, both known and hidden, were as vast as her area, and there ought not to be any cause for alarm regarding shrinkage or space to live in. The problem, continued Dr Lal, however existed not to cause alarm but to bring into play the constructive efforts of science, social workers and Governmental agencies so that life for the Indian masses might become more attractive, with greater physical comforts and amenities of thought, culture and social intercourse. Human population, if properly organized and developed, might instead of being a dead burden to the country, be an asset of the highest order. It was *man power*. But is India really alarmingly over populated? In 1931, the density of population per sq. Km. was 75 in India, as compared with 76 in France, 134 in Italy, 139 in Germany, 171 in Japan, 194 in Great Britain, 240 in Holland and 268 in Belgium. If, then, the vast latent resources of this country are tapped and national wealth developed, there seems to be no cause for alarm, even when no artificial measures are adopted to check the rate of increase of population. Efforts must therefore be made to utilize fully the resources of our land, to strengthen man power, and raise social, health and economic standards through the advancement and application of science.

Need of Research in Indigenous Burmese Medicines

Col. N. S. Sodhi, I. M. S., Inspector-General of Civil Hospitals, Burma, speaking at the annual dinner of the Burma Medical Association, suggested the amalgamation of various medical associations in Burma and advisability of systematic research work into the various systems of indigenous medicines. To-day greater attention is being paid to the carrying out of systematic investigation into the efficacy or otherwise of indigenous drugs and medicines in India and considerable work is being done by Bt. Col. Chopra and his workers in this field. A number of of these have been proved to be of great efficacy and value and, in case they are standardized, can be administered with advantage, thus helping a native industry and at the same time bringing the native pharmacopœia in line with modern scientific methods. Burma has long been intimately associated with India, and owes its civilization in a large measure to this country. It is but natural that the indigenous medical science of Burma is largely indebted to the Unani and Vaidic systems of India, and thus requires equal attention. Col. Sodhi, in course of his speech, said: "In a vast country like Burma where the Burmese sesayas (indigenous medical practitioners of Burma) have been in existence for centuries and where indigenous medicines must have been used with great advantage and success for years, we would be doing a great injustice if we condemn them as useless or hopeless. My information from very reliable and highly placed educated Burmans is that some of the drugs of the sesayas are marvellous. I know that some of the Unani and Vaidic drugs are excellent and we also know that some of the drugs used in allopathic medicine are infallible. Let us therefore try and cooperate and get hold of good Burmese drugs, Unani or Vaidic drugs, and try them on cases and see what effect they have on definitely diagnosed diseases. A great deal of research work of this type on indigenous drugs of India (Unani and Vaidic) is being done at Calcutta under the guidance of Col. Chopra. This is the line which I suggest we might take up in Burma."

Arrangement for Forest Ranger's Training in Bombay

The Madras Government having decided to close down the Forest College at Coimbatore with effect from July 1, 1939, the Government of Bombay have decided to provide for the training of Forest Rangers at the Agricultural College, Poona, where a Forest Officer will be deputed, for specialized forestry training, as Forestry Instructor. The instruction of Ranger students will be divided between the staff of the Agricultural College and the Forestry Instructor. The terms will be from 10th June to 30th September and from 1st November to 20th February, and the training in practical field-work will be given in the months of October, February, March, April, May and June. The fee for students sent to the College by the Bombay Government will be Rs 250/- per annum and that for other students Rs 500/- per annum.

NOTES AND NEWS

Yet another Attempt on Mount Everest

In spite of the several dismal failures in the past to conquer Mount Everest, yet another attempt is to be made to assault it. After the first Everest "reconnaissance" of 1921 General Bruce failed to conquer it in 1922, Lt. Col. Norton in 1924, Mr Ruttledge in 1933, Dr Shipton in 1935, and Mr Ruttledge again in 1936. The largest mountain peak of the world has although remained unsubdued, the risky adventure to climb it is yet unfinished and is to be hazarded anew. Mr H. W. Tilman is to lead the new expedition. He is accompanied by a small band of friends -Odell, Smythe, Shipton, Oliver, Lloyd and Warren—all expert and experienced mountaineers. The rather largish parties having failed in the past, the venture is being made with a small but impressive band. From a telegraphic message sent to *The Statesman* of Calcutta on April 6, 1938, by Mr Tilman, it is learnt that the Expedition established its base camp on that date near the snout of the Rongbuk Glacier, twelve miles from the goal of its adventure. No predictions have been made regarding the methods of campaign, and no fixed programme of attack has been chalked out perhaps that is due to the eccentric and elusive nature of Mount Everest. It has hitherto been invincible. It is eluding the best human efforts. But the scientist of today is equally tenacious and persistent and has a peculiar charm for the elusive. He will not rest contented till the Mount has yielded to him. Meantime the struggle will go on undauntedly, for every attempt made is a gain and every new inch covered is an achievement. We earnestly hope that the expedition led by Mr Tilman may meet with success.

Strange Cause of Fish Mortality

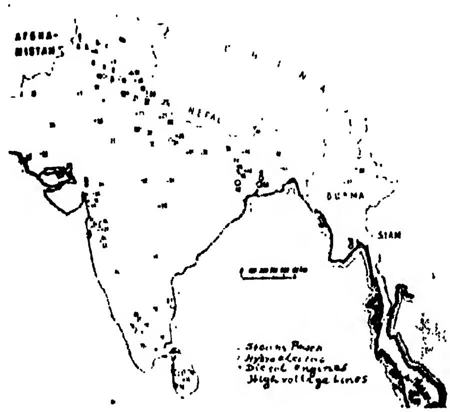
A strange instance of the widespread mortality among fish in the lower reaches of the Dakatia river about 10 miles below Chandpur in the Tippera district (Bengal) was reported to the Fisheries Expert during his tour there last month. A microscopic examination of the gill filaments of a large murrel fish *ophiocephalus marulius* (Bengali Gojar), says a note issued by the Press Officer with the Government of Bengal, revealed that the causative factor was the clogging of the gills by swarms of a particular species of a microscopic organism. This organism caused an amber-coloured discolouration of the water in the area affected, popularly known as "red-water-phenomenon." Such phenomena have not up till now been noticed except in isolated regions of the world such as the Malabar coast of the Madras Presidency, off Japan, etc. The discolouration has been found to be due to the occurrence of dense swarms of a particular species of unicellular microscopic organism to the exclusion of all other organisms in a *limited* area in the *open* sea or a *wide* shoot of backwater. Such a discolouration was noticed by the Fisheries Expert also at the mouth of the River Passur during his tour of the Khulna district (Bengal) in February. The organism causing this discolouration was found to be a species of *Dinoflagellate* (a minute unicellular organism). Owing to the overcrowding of these organisms in these waters there is a deficiency of oxygen and an excess of carbon dioxide which condition is fatal to all animals coming within the area affected. Besides, the dead animals decaying in large numbers and the resultant matter, usually of a yellowish jelly-like consistency, have also a toxic effect upon other living animals. The rapid multiplication of these microscopic organisms is rendered possible by a concentration of nitrates and phosphates brought down by land drainage under favourable conditions such as bright sunshine.

These discoloured patches are often distributed widely, sometimes within a few hours or a few days, by strong winds or water currents. When the volume of the organisms is thus thinned out, they have no deleterious effect, but on the contrary, form a rich source of food for fish. If nature does not cause even distribution of the coloured area, wide meshed drift nets may be drawn across the affected area to facilitate the distribution required.

India's Electrical Power

The following table will be very interesting to our readers, especially to those who have followed the article, "An Intelligent Man's Guide to Economics of Electrical Power," by Prof. M. N. Saha and Dr A. N. Tandon, published in SCIENCE AND CULTURE, *3*, 506-10 and 574-79, 1938. It is the list of various places in India, in which electrical power has been installed, and this is given in kilowatts under three heads steam, diesel and water. Those places whose installed electrical power is less than 500 kilowatts have been omitted. The numbers shown in the accompanying map indicate the locations of the

various places of the list on the map; for example, Delhi's number is 24 in the list, and this is shown on the map to enable the reader to find out its position. Both the list and the map are taken from an article by P. Fr. Von Stritzt in the *Elektrotechnische Zeitschrift*, 57, 1247, 1937.



INSTALLED ELECTRICAL POWER IN KILOWATTS

	Steam.	Diesel.	Water.
1. Malakand . .		..	9,600
2. Peshawar .	900 800	..	..
3. Khaur . .	735	..	..
4. Rawalpindi .	3,830	500	..
5. Mohora (Srinagar) . .	..	..	4,000
6. Khewra . . .	..	700	..
7. Jammu . . .	..	..	1,200
8. Sialkot . . .	..	625 295	..
9. Darival . . .	..	900	..
10. Lahore . .	10,000 7,600	..	..
11. Amritsar . . .	..	1,325	
12. Mandi (Kalpi R.)	..	..	48,000
13. Quetta . . .	..	650	..
14. Renala . . .	..	..	1,100
15. Jullender . .	..	606	..
16. Simla . . .	..	550	1,750
17. Multan . . .	..	770	..
18. Patiala . .	920		..
19. Dehradun . .	..	.	4,000
20. Bahadrabad .	..	..	5,700
21. Saharanpur .	..	750	..
22. Sumera . .	..	1,885	..
23. Nainital . .	..	..	800
24. Delhi . .	6,400	..	..
25. Sukkur . .	..	1,350 675	..
26. Bikaner . .	2,370	..	..
27. Bareilly . .	825		..
28. Shahjahanpur .	..	500	..
29. Muttra . .	..	500	..
30. Agra . .	..	1,160	..
31. Ajmer . .	2,150	..	..
32. Gwalior . .	2,000	.	..
33. Lucknow . .	2850		..
34. Cawnpore .	34,500	..	..
35. Hyderabad (Sind)	..	1,020	..
36. Karachi .	7,370		..
37. Allahabad .	3,950	215	..
38. Benares . .	5,000	.	..
39. Patna . .	1,860	..	..
40. Darjeeling .	..	..	1,130
41. Bhagalpur .	..	900	..
42. Jamalpur .	3,950	..	..
43. Dacca . .	..	1,500	..
44. Giridih . .	4,650	..	..
45. Sijua . .	1,000	..	..
46. Dishargarh .	1,000	..	..
47. Kargali . .	3,000	..	..
48. Jamshedpore .	53,200	..	..
49. Gourepore .	29,350	..	..
50. Calcutta .	1,83,375	..	..
51. Jubbulpur .	3,200	..	..
52. Bhopal . .	1,100	..	..
53. Ahmedabad .	17,910		..

	Steam.	Diesel	Water.
54. Godhra . .	500	2,000	. .
55. Baroda . .	. .	. .	. .
56. Broach . .	. .	750	. .
57. Surat . .	. .	1,520	. .
58. Nagpur . .	1,550	. .	. .
59. Khopoli . .	. .	. .	48,000
60. Andhra Valley	. .	. .	48,000
61. Bhora . .	. .	. .	87,500
62. Bhatghar . .	. .	. .	1,024
63. Poona . .	3,680	. .	. .
64. Hyderabad (Deccan) .	9,000	. .	. .
65. Gokak . .	. .	. . .	1,250
66. Kolar . .	2,500	. .	. .
67. Madras . .	3,400	. .	. .
68. Sivasamudram .	. .	. .	42,000
69. Karteri . .	. .	. .	1,000
70. Glen Morgan .	. .	. .	1,000
71. Pykara . .	. .	. .	18,750
72. Trichinopoly .	. .	690	. .
73. Munnar Valley	. .	. .	1,100
74. Madura . .	. .	750	. .
75. Kandey . .		550	. .
76. Colombo . .		11,940	. .
77. Mandalay .	. .	1,365	. .
78. Rangoon . .	14,000	. .	. .
79. Kedah . .	. .	857	. .
80. George Town (Penang) .	14,500	. .	. .
81. Perak . .	28,500	. .	27,000
82. Kampor . .	. .	. .	1,000
83. Pahang . .	. .	. .	1,100
84. Kuala Lampur .	15,000	. .	. .
85. Pagkalen . .	3,750	. .	. .
86. Malacca . .	. .	700	. .
87. Singapore .	22,000	. .	. .
88. Nam tu . .		2,840	10,000

The last few places are not shown in the map.

Brevet Col. R. N. Chopra

We are very glad to be able to announce to the readers of SCIENCE & CULTURE that Brevet Col. R. N. Chopra, M.D., Sc.D. (Cantab), I.M.S., Director of the Tropical School of Medicine, Calcutta, has been elected an Honorary Member of the American Society for Pharmacology and Experimental Therapeutics in recognition of his outstanding services to the science of Pharmacology.

In informing Col. Chopra of this distinction the Secretary of the Association writes that so far the society has admitted only three others to this unique honour, *viz.*, Prof. Hans Meyer of Vienna, Prof. Straub of Munich and Sir H. H. Dale, Director of the National Medical Research Council of Great Britain, and a Nobel Prize man.

It is well known that Col. Chopra has been Director of the Calcutta Tropical School of Medicine for a number of years, and besides his personal contributions of great merit, has built up a fine school of Pharmacology and Experimental Therapeutics. Every Indian should feel flattered by the unique honour conferred on him. In a future issue, we hope to publish a detailed article on his scientific works, and on the development of the Tropical School of Medicine under him.

Science in Industry

Government's Proposed Economic Surveys and Studies

Dr T. E. Gregory, who was appointed as Economic Adviser to the Government of India, has been in this country long enough to survey the scope of the tasks that will be entrusted to him and the nature of the organization which he is required to build up. It was not the object of the Government in appointing their Economic Adviser merely to promote the abstract investigation of Indian economic problems. The exact scope of his activities is somewhat tentative and will become more clearly defined, the Government believe, in the light of experience. Besides the current economic and financial problems with which the Government has to cope from day to day, a series of investigations, it is hoped, will be undertaken of a more general character, which are not immediately related to the current work of administration. Among the first of these projects, some will, the Government believe, be of definite educational value to the general public, for it is hoped to issue a guide to official economic and statistical literature, which will make the existing vast mass of material more readily understandable. It is proposed also to increase the usefulness of the existing publications, such as the *Annual Review of the Trade of India*, *Monthly Survey of Business Conditions in India* (a beginning has already been made in this case) and *Statistical Tables relating to Banks in India*, by improving the contents and widening their scope. Apart from these, the subjects of study will include bilateral trade policy, the transfer problem between agriculture and industry, the limitations and possibilities of public works policies in a country like India, and the general economic results of the policy of discriminating protection. The possibility of compiling a descriptive economic survey of India is under active discussion. Though such a survey would of necessity, as the Government think, be an elaborate undertaking and would require some years to complete, it is essential for the industrial development of the country and all the more necessary in view of the economic surveys at present being seriously contemplated by the various provincial Governments.

Bombay Chemists' Suggestions for Industrial Development

Some very useful suggestions concerning the development of provincial industries are contained in a memorandum which the Bombay Chemists have decided to submit to the Government for their consideration. The chemists suggest the creation of a provincial scientific and industrial research council, revival of workers' guilds, remodelling of technical education and technical institutions, co-ordination of research work for industries throughout the Presidency and the reorganization of the Department of Industries to enable it to be of greater utility. The function of the research council will be to advise and guide the Government in moulding their policy towards fostering and developing both large scale and cottage industries. An industrial survey, they state, of the natural resources should be immediately undertaken and a systematic planning of the industries in order of importance be made. Thorough co-operation between the research workers and various institutions needs to be organized and encouraged. A periodic survey of the existing industries should also be undertaken to offer advice and guidance. An industrial and co-operative bank should be established by the Government to help both large-scale and cottage industries. Technical Institutes should be remodelled to supply the right kind of trained men from artisans to supervisors and managers, for different industries. Whenever chances for a new venture are small and capital is shy, the State should undertake the enterprise which, when successful, may be handed over to a private concern. The Government should, on the advice of the proposed council, take steps to establish closer and more efficient contact between scientists and industrialists and between scientists and public leaders. If and when a particular industry has

sufficiently advanced and developed, a separate research association for it may be encouraged. To revive cottage industries, it is essential to make a survey, to revive the various guilds (such as those of printers), to provide expert advise regarding machinery, to encourage buying and selling of raw materials and manufactured goods on co-operative bases, to arrange for the better education, health and other needs of life of the workers, to standardize the materials turned out, and to follow this up by propaganda work to create lasting interest in *swadeshi* articles. The Department of Industries should be so reorganized by the Government, as to achieve the necessary objectives, such as a collection of up to date information; provision for expert advice, efficient supervision of cottage industries by the revival of guilds, provision and efficient supervision of the right kind of technical training, rendering all kinds of active help to the provincial scientific and industrial research council, maintenance of a scientific and technical library, marketing and propaganda work, and cheap power and transport facilities for industries.

It may be mentioned in this connexion that the Bombay Government have already decided to plan a systematic industrial survey of their Province. The Bombay Economic and Industrial Survey Committee have held two meetings so far, and have already decided on the lines on which they propose to conduct their inquiry. It has been decided to appoint three investigators who under the direction of the Committtee will conduct intensive surveys of the existing industries in the Central, Southern and Northern Divisions, and it is likely that a fourth investigator may be appointed to conduct a similar survey in the City of Bombay. The Committee has also in view the appointment of Divisional Committees in the three divisions, consisting of persons well acquainted with the industrial and rural life of their districts and who will be of assistance to the Committee in collecting information and will be able to supervise over the work of the investigators. The Committee has decided not to issue a formal questionnaire. Instead, they have elaborated in detail a statement of the heads of inquiry under which they propose to collect information, and a copy of this statement has been sent to important commercial and industrial associations, officials of Government, agents of the All-India Village Industries Association and selected individuals with a request that they may be pleased to furnish to the Committee such information as they can under any of those heads of enquiry in which they are interested.

A copy of the statement will be issued for publication in the Press very shortly.

Need for Industrial Survey of Bengal

In the Province of Bengal, the progress of industrialization has been relatively slow. The Bengal National Chamber of Commerce investigated into the causes of this, and they found that the majority of the small industries suffered considerable handicaps both in regard to the production and distribution of their goods. In a letter addressed to the Government of Bengal, the Committee of the Bengal National Chamber of Commerce stress the necessity of instituting, at an early date, a thorough and comprehensive industrial survey of the province. They point out that while in many cases the industries would urgently require adequate tariff protection against foreign competition, a mere tariff assistance would not solve the problem of a large number of industries. What is required, on the other hand, the Committee state in the course of their letter, is a well conceived and comprehensive plan based on such conditions as may be revealed by an Expert Committee and further investigations into the potentialities of new lines of industrial development. The results of such an inquiry will, no doubt, be of great help to the existing industries by indicating the lines along which they may take steps for improving their methods of production and distribution.

The Committee propose that the enquiry should be entrusted to an Expert Committee consisting of Departmental officials, representative industrialists, and economists to be nominated from the Universities of Calcutta and Dacca, and suggest that the terms of the enquiry should comprise the following points:

(*a*) The number and variety of industrial concerns throughout the Province, (*b*) the extent to which they fall short of the economic size, (*c*) the financial resources and requirements, (*d*) the provision of power, (*e*) the handicaps resulting from antiquated machineries and out-of-date methods of production, (*f*) the

quality of raw materials locally available and methods by which the deficiencies therein may be neutralized. (*g*) the quantity of raw materials which the industries have to import from abroad and the incidence of customs duties imposed thereon, (*h*) the freight charges which the industries have to pay for the transport of raw materials and finished goods, (*i*) the incidence of labour legislation, (*j*) the ultimate cost of production of the goods, (*k*) the existing system of marketing and (*l*) the measures which may be necessary to adopt to solve the problems facing the industries.

Radio valves and Philips

Philips have built up a reputation in the manufacture of radio valves and allied accessories of distinction. They have always undertaken programmes of consistently developing their valves with peculiar regularity bearing a threefold responsibility on behalf of themselves, the wholesaler and of the listening public. An extremely well-designed and finely printed brochure from Philips has come to our notice. In it they have preferred to clearly lay out their regular processes of progressive improvement made on their own valves. No innovation has been ushered into the market, to the fundamental basis of which they could not adhere throughout the successive years. For the sake of this principle of maintaining essential regularity, they announce how a type of valve whose patent had been taken as Cupra-Miniwatt was abandoned so late after the first trial manufacture.

One of the recent phases of their progressive development has been the constructional feature of directed electron beams. The manufacture of Cathode ray tubes and the study of the field of electron optics suggested this new principle in the construction of the valves. The paths of electrons from the cathode to the various grids and to the anode have been carefully studied and the electrons have been "disciplined" to endow the valves with better electrical characteristics. The evolution of this method has been found in the high quality octodes and H. F. pentodes, which, Philips declare, have solved three outstanding problems, *viz.*, the conversion problem (also on ultra short television waves), the problem of reducing the noise to signal ratio, and the problem of volume control.

Mineral Deposits in Tripura State

The Geological Survey Department of the Tripura State has issued a press-note in which they announce the existence of large petroleum reservoirs as evidenced by recent investigations carried out in the Baramura and Dostmura ranges in the State. There are, says the press-note, several parallel ridges about 10 miles apart running north to south with suitable anticlinal structures, numerous gas-seepages, and saline springs which are indicative of oil below. Besides petroleum and natural gas, there are large deposits of kaolin and fire-clay. Manganiferous iron ores and bauxite have also been found, and there are likely to be found, it is said, good deposits of bentonite, impure varieties of which have already been found. There are also suitable building materials and road metals. Most of the area is still unexplored, and possibilities are said to exist of finding other mineral deposits of economic value. Details about the investigations of the Geological Survey and also samples may be had from the office of the Geological Department of the Tripura State.

Proposed Utilization for Coal

When coal is burnt in its native state, many valuable substances escape through smoke. In collieries, soft coke is manufactured by firing heaps of coal in the open air, which amounts, it is said, to a dissipation of the national reserve. A process by which coal may be utilized without burning it, in generating electricity, is being evolved, it is reported, by Mr S. K. Sinha, Special Officer, Bihar Electrification and Tube Well Scheme, who is trying to get the best advantage out of coal by using it to generate energy for electrification in the Province of Bihar. His purpose is to find out whether, instead of burning coal directly in its native state, it would not be desirable and profitable to fractionate it, and after recovering valuable liquids and solids, to utilize the gaseous byeproducts for the purpose of either driving gas engines or heating boilers for suplying steam to turbo-generators. According to Mr Sinha, the Bihar Electrification Undertaking would consume at a modest computation, 200–400 tons of coal per diem. This coal, when fractionated, will yield soft coke, gas, light oil, medium oil, and heavy oil, in commercial quantities. The light oil will be suitable for running crude oil engines, the medium quality, which will contain a lot of carbonate acid, will

be invaluable for treating timber, and the heaviest liquid products will be suitable for road dressing. Mr Sinha is very hopeful about the success of his process. He has discussed it with Dr H. K. Sen, Director of the Indian Lac Research Institute, Ranchi, who has given him great encouragement and also agreed to carry out experiments for him. Mr Sinha is likely to complete his investigations regarding all the aspects of his process, and it is possible he will ask the Government to have his scheme examined by a committee of experts.

Suspected Gold Deposits in Jashpur State

Jashpur State in the Eastern State Agency possesses some gold producing area which is underlain by gneissic rocks, cut by innumerable veins of quartz and tourmaline-quartz rocks, and is drained by the river Ib and its tributaries. Sparsely disseminated gold occurs at many places, but the outstanding feature of the area is the occurrence of an auriferous gravel bed under the alluvium in the bank of the Ib and its tributaries, the Maini and the Sonajori. Evidences of old placer mining are abundant in the area. At present no digging of any kind is allowed and the only gold now obtained comes from the washing of the river sands and the soil mantle on the stream banks and on the divides between the *nalas*. The Geological Survey of India recently conducted investigations in the principal gold-producing area of the State, and studies of the physical characteristics of the gold and the distribution of the auriferous alluvium have led them to believe that gold has been derived from the quartz veins which are so abundant in the area. As these have not been prospected yet, the Geological Survey authorities hope that during the ensuing field season, suitable operations will be undertaken in order to indicate the economic possibilities of these gravels.

Our Industrial Article for June

The following article on "Production of Liquid Fuel from Water Gas" has been contributed by Mr Durgadas Lahiri for our section of Science in Industry of the present issue of the Journal. In this the author describes a process by which liquid fuels may be obtained from coal.

Production of Liquid Fuel from Water Gas

Durgadas Lahiri
Department of Applied Chemistry, Calcutta University.

The earliest fuel used in furnaces for the generation of power was wood, which, due to its various disadvantages, has been replaced by more efficient fuels, coal and coke. But when compared with liquid fuel which is gradually though slowly replacing solid fuel, it has various disadvantages. Thus where rapidity of firing, cleanliness, attainment of a high temperature in a short time and its accurate maintenance are required, solid fuels cannot be used except with special care. Besides, liquid fuels have higher calorific value, leave very little ash, occupy smaller volume, are clean to use and require fewer men to attend the furnace. Liquid fuel has reduced the discomfort in loading fuel, clinkering fires and stoking. And the most important point in favour of the use of liquid fuel is that it has greater energy and efficiency than coal or coke. Consequently the use of coal, as it is, is a wasteful one. Incidentally, it may be said that the coal-reserves are limited, and, therefore, special care should be taken to minimize wasteful handling. In India, for instance, the total reserve is only 80,000 million tons for a population of 350 millions. At present our annual raising is about 20 million tons and if this were kept constant—a very improbable assumption—the reserve can last only 4000 years.

The question then arises as to why liquid fuels

are not so extensively used. The answer is short. It is the limited supply of liquid fuel with its consequent heavy cost. At present the sources of liquid fuels are distilled products of petroleum, shale, tar, and alcohol, etc. These sources are so very limited that a general replacement of coal by them cannot be done. Moreover, petroleum which is the main source of liquid fuel may fall short in not very distant future. As far as India and Burma are concerned, we are producing about 320 million gallons of petroleum annually. If the total reserve be computed at 20,000 million gallons the total reserve may last for 60 years. If, therefore, liquid fuel is to be used we shall have to look for other sources than petroleum. And as this fuel problem is a world-wide problem, chemists and engineers in different countries have turned their attention to obtain liquid fuels from coal.

Three processes, which are still being developed, are:—

(1) Low temperature carbonization of coal;

(2) Franz Fischer's methanol and synthol processes or the conversion of water gas into paraffins; and

(3) Bergius liquefication of coal.

By the first process a much greater amount of tar of lower sp. gr. can be obtained than by high temperature distillation. The quantity of gas is no doubt less but it has higher calorific value and candle power. The coke obtained is much more useful for domestic purpose as it can be used as a smokeless fuel and can be lighted easily. Thus the following average yields per ton of coal by high and low temperature carbonization will make the thing clear—

Tempt.	Cu. ft. of gas.	Tar in gallons.	Sp. gr.
900°C (high)	11,000	9	1.2
500°C (low)	6,400	21	1.087

In the third process the coal is subjected to a pressure of 150-200 atmospheres in presence of hydrogen at about 450°C. 85-90% of the coal is converted into liquid products.

In the second process, which I am describing here, the coal after low temperature carbonization is converted into water gas. This water gas is converted into methanol or synthol under pressure or into hydrocarbons at atmospheric pressure in the presence of suitable catalysts.

The use of CO as the starting point in the synthesis of liquid products was first pointed out by Sabatier in 1905. As two of the valency directions of the molecule are unsaturated and these were known to be readily taken up by oxygen, sulphur, chlorine, etc., he pointed out that under suitable conditions combination with hydrogen should be possible to yield either aldehyde or alcohol. Till 1913 the only reaction established by the passage of CO and H_2 over a catalyst was that resulting in the formation of CH_4, CO_2 and H_2O.

For a long time, therefore, the search for a catalyst capable of converting water-gas into intermediate reaction products appeared to be the only course left. A clue to it was found in the difference in the behaviour of zinc formate and potassium formate. While potassium formate is formed from KOH and water gas at ordinary pressure, zinc formate is formed from zinc-oxide and water gas at considerably high pressure. The former yields on decomposition potassium oxalate and H_2, while the latter gives formaldehyde, methyl formate and methanol. The residue, of course, is zinc oxide which can regenerate zinc-formate. This reaction exercised no small influence on the selection of catalyst, but the precise manner in which it acts is not known. The use of high pressure was warranted by the already known fact that below red-heat ZnO decomposes methanol into CO and H_2 and it was considered that the same catalyst under high pressure might induce the reverse reaction. The fact can be readily anticipated from La-Chatelier's principle as $CO + 2H_2 \rightleftharpoons CH_3OH$.

By using ZnO Patert and Fischer obtained methanol in almost theoretical yield. Though this alcohol has very little use as a fuel it has other uses, for instance, for the manufacture of formaldehyde (which has a great diversity of applications, particularly for the Bakelite industry) for methylation, denaturation of alcohol, etc.

Fischer attacked the problem mainly from the point of view of producing a mixed product suitable as a fuel for internal combustion engines. He employed a catalyst iron, impregnated with a strong base and the reacting conditions were a temperature of 410°C

and pressure between 70 and 150 atmos. The end product consisted of a mixture of alcohols, aldehydes, ketones, acids, together with a series of hydrocarbon (2%) up to C_9. The boiling range of this mixture was from 60 to 120°. It had a calorific value of 7500-8200 Cal. (petrol– 11,000). The yield was 3Kg. from 10 cu. m. of $CO + 2H_2$ Experiments with a petrol engine gave very satisfactory results.

The reactions involved in the formation of the products, as explained by Fischer, are as follows:—

$CO + 2H_2 \quad CH_3OH$

$CH_3OH + CO \quad CH_3COOH$

$2CH_3COOH \quad CH_3COCH_3 + H_2O + CO_2$ (side reaction)

$4CH_3COOH + H_2 \rightarrow CH_3CHO + H_2O$

$CH_3CHO + H_2 \rightarrow CH_3CH_2OH$

$C_2H_5OH + CO \quad C_2H_5COOH$ & so on

The Badische Company have endeavoured to produce pure products with the help of this reaction. This Company employed as catalyst mixed oxides of Zn & Cr (ZnO, 90%; Cr_2O_3, 10%) and, at a pressure of 150 to 250 atmospheres and at a temperature of 400-425°C they obtained good yields of methyl alcohol. Audibert also obtained pure methyl alcohol using Cr and U at 200 atmosphere pressure and 225-300°C. His gas consisted of a mixture of $CO + H_2$ and he demonstrated that only above 300°C side reactions begin, which result in the formation of other alcohols and CH_4.

The process of Bergius as well as the methanol and "synthol" syntheses which depend chiefly upon pressure have lapsed somewhat into the background since Franz Fischer himself the discoverer of the "synthol" synthesis carried out his remarkable work on the hydrogenation of CO into paraffins at ordinary pressure. In fact, wherever possible high pressure technique has been abandoned in favour of ordinary pressure and this is due to its inherent difficulties. In this process water-gas with some admixture of H_2 is passed over the catalyst at a definite temperature when liquid hydrocarbons are formed. The catalysts are prepared by the reduction of the oxides of Fe, CO, Ni, etc. The theory on which Fischer bases his work is that high carbon carbides are formed on the catalyst and that these are decomposed to form the methylene group which polymerizes to form saturated hydrocarbons.

After Fischer and Tropsch had begun their synthesis of liquid products at ordinary pressure, various investigators in different countries have extensively developed the process. Besides Fischer and his collaborators, Smith and his co-workers, Elvins and Nash, Erdely and Nash, Levy and his collaborators, Smith and his collaborators, Muller, Jungling, Kobayaeshi and his collaborators Kodame, Fujumera, etc., have contributed materially to the advancement of this subject.

At present it is reported that several factories are working for producing liquid products by this process.

The various catalysts which have been found to give good result are as:—

(1) Co– Cu– Thorium-Kieselguhr catalyst
(2) Ni—Mn—Al_2O_3
(3) Ni—Mn—Th, etc.
(4) Co –Cu –Th –U, etc.
with promoters such as alkalies.

As the reactions of the formation of hydrocarbons are attended with the evolution of heat and contraction of volume, it can be readily anticipated that high pressure and low temperature are favourable for the formation of liquid products. But at high pressure oxygenated products are formed and difficulties of high pressure technique have diverted the attention of investigators to this field where high pressure is not resorted to.

The optimum temperature is found to be near about 210°, though it varies with different catalysts. The catalysts are prepared by the reduction of the oxides with hydrogen at the temperature of the reaction. Sulphur compounds and high temperature are found to have a deleterious effect on the activity of the catalyst. The optimum gas velocity, gas mixture and the catalyst space have been studied. It has been found that a gas mixture of the ratio of $CO:H_2$ 1:2 is the optimum mixture in agreement with the equation

$$9CO + 19H_2 \rightarrow C_9H_{20} + 9H_2O$$

Excess of hydrogen favours the formation of methane.

A definite mixture of CO and H_2 can be produced in the following ways:-

(1) $C + H_2O \rightarrow CO + H_2$ (by passing steam over coke at 1000°C).

(2) In the presence of Ni catalyst, by the reaction $CH_4 + H_2O \rightarrow CO + 3H_2$.

Hydrogen can be obtained from coal gas, and natural gas and gases from cracking oil.

CO through reduction is a ready source of CO, the reducing agents may be coke, H_2 and CH_4, as shown below:

$$CO_2+C \longrightarrow 2CO$$
$$CO_2+H_2 \longrightarrow CO+H_2O$$
$$3CO_2+CH_8 \longrightarrow 4CO+2H_2O.$$

It has been reported that water-gas containing 42% CO asd 48% H_2 gave a yield of 160 cc of oil per cu. metre of water-gas using Ni-Mn-Al catalyst. On the basis that 40 lbs. of coke produce 1000 cu. ft. of water gas, this is equivalent to about 60 gallons of oil per ton of coke.

It appears that this process of synthesis of liquid fuel at ordinary pressure coupled with low temperature carbonization which provides the coke for the production of water-gas and valuable by-products is fraught with great industrial possibilities.

Thus starting with one ton of coal we can get by carbonizing at 500°C about 14 cwt. of coke, 6400 cu. ft. of gas of calorific value 750 B.T.U. and 21 gallons of tar of 1.087 sp. gr.

This tar on distillation gives

2 gallons of light spirit

5.5 gallons of heavy neutral oil.

This coke (14 cwt.) would give according to the former data about 40 gallons of liquid products by Franz Fischer's synthesis.

In a recent paper in *Petroleum Times* Fischer gives the percentages of different products he has got by this process and these are as follows:—

8% Gasol.
62% Motor spirit.
24% Diesel fuel.
2% Paraffin wax.
4% Ceresin.

Thus calculation shows that by the combination of the above two processes we can obtain from 1 ton of coal about 27 gallons of motor spirit, 15.4 gallons of Diesel fuel and different amounts of other valuable of products.*

* Read at the Calcutta Chemical Club on the 6th March, 1938.

"Rubber" From Tung Oil

A Rubber substitute which stretches, snaps back and in many respects resembles and behaves like natural rubber can be made from tung, soya been and other vegetable oils, according to a patent granted to Harvey G. Kittredge of Dayton, Ohio. (Pat. No. 2,114,427).

In some features the new rubber substitute is superior to the natural product, the inventor asserts. Many acids and alkalis do not affect it. Oil and greases do not attack it.

As substitute for natural rubber in paints, and varnishes and as a coating for textile material, the tung-oil " rubber " already is finding widespread use, it is stated. It can be vulcanized like natural rubber with sulphur, yet the vulcanized product contains no free surphur, which is considered objectionable in rubber for certain uses.

The new rubber is made by heating a mixture of tung oil and glycerine to about 410 to 450 degrees F. until complete reaction takes place. What chemists term " heat polymerization " occurs. Molecules of tung oil and glycerine join with one another to form the rubber substitute. No milling is required.

Besides tung and soya bean oil as the starting material, oriticica, perilla and cottonseed oil may be used.

Use of the new rubber substitute for auto tires is not mentioned in the patent, but it is noted that it may be mixed with natural rubber.

—*New York Times.*

Research Notes

Restricted Rotation About a Single Bond

Although the classical as well as the modern quantum-mechanical theories of valence allow free axial rotation about a two-electron bond, instances are increasing in number where such a rotation is considerably restricted due to mutual interaction of the groups. Some time ago, Mizushima and co-workers attempted to prove this restriction in a series of communications (*Sc. Pap. Inst. Phys. Chem. Res.*, *29*, 63, 111, 188, 1936.) in several halogen derivatives of ethane from measurements of their dipole moments in solution and comparison of their vibration spectra in the liquid and solid states. More recently, from measurements of the heat capacities of ethane, Kemp and Pitzer have adduced strong evidences (*Jour. Am. Chem. Soc.*, *59*, 276, 1937), for the existence of a potential barrier of 3150 cal./mole between configurations of maximum and minimum potential energy. Comparison of entropies obtained from molecular data with those derived from the third law of thermodynamics has indicated similar high values of potential barriers in molecules like ethyl alcohol, acetone and iso-propyl alcohol. (Schumann and Aston, *Jour. Am. Chem. Soc.*, *60*, 985, 1938).

The intramolecular potential of such compounds often show several minima (Eyring, *Jour. Am. Chem. Soc.*, *54*, 3191, 1932, Smyth and, McAlpine, *ibid*, *57*, 979 1935.) indicating possibility of several stable configurations. Since the thermal energy (kT) which aids to overcome restriction of rotation is of the order 600 cals per mole only at room temperatures, it follows that transformation from one stable configuration to another by axial rotation is often considerably restricted at ordinary temperatures, still more so at low temperatures. Attempts to experimentally demonstrate the existence of isomers of these restricted rotators by fractionation at low temperatures will be interesting.

—*J. G.*

Blood Groups and Genetics

The fundamental aspects of the blood groups were first summarized by Dr V. Friendenreich (*Ann. Eugenics*, *8*, no. 2) in delivering the Galton Lecture at the University College, London, on 17th March, 1937.

The substances on the presence or absence of which the blood groups depend are sharply characterized by serological properties; they are not demonstrable by chemical means, and we have rather a vague idea of their chemical structure. These substances known as antigens give rise to antibodies when injected in a foreign organism. The reaction is demonstrated by agglutination, and in this reaction the antibodies are fixed to the cells and thus removed from the fluid. This part of the process is known as absorption.

Landsteiner in 1900 discovered the phenomenon of iso-agglutination. He assumed the existence of two different antigens in the blood corpuscles and two corresponding normal agglutinins in serum. Ten years later (1910) von Dungern and Hirszfeld demonstrated the hereditary properties. and inheritance follows the Mendelian laws. The frequency of the factors differs in different parts of the globe. Going eastwards towards Asia the frequency of B increases, that of A decreases, whereas the fairly pure North American Indian tribes show practically no other groups than O. These phenomena are of great interest in connexion with the problem of the origin and distribution of the human races. Von Dungern and Hirszfeld showed that A and B properties are due to dominant gene while the O property is recessive. Their assumption of the two independent pairs of genes was modified by Bernstein in 1924. Bernstein advanced a three allelomorphic gene hypothesis. Thus according to Bernstein three blood grouping genes are all localized in the same chromosome.

The blood corpuscle A reacts less strongly than

others, and this led some investigators to assume two kinds of A corpuscles. Landsteiner and his collaborators in 1926 showed that all A individuals could be placed in two subgroups A_1 and A_2. Friedenreich along with Dr Worsaae carried out a systematic quantitative examination of the absorption power of the corpuscles in one hundred A persons and in a clear graph showed the 'strong' and 'weak' types according to their absorption power. These were found identical with Landsteiner's A_1 and A_2. This bipartition of the A groups has a simple genetic basis. The allelomorphic genes are not three but four, namely O, A_1, A_2, B, with A_1, A_2, and B dominant to O and A_1 dominant to A_2.

Turning to non-human blood Friedenreich said that the blood groups have arisen independently as parallel mutations in the anthropoid and humanoid stocks. The so-called A and B antigens are not single elements but a compound of several compounds. No animals other than the anthropoid apes contain all of them but some of the components are found in many other species of the animal kingdom while in some they are absent; thus the Forssman antigen is common to all sheep whilst in man it forms part of the group character A. It is a matter of great biological interest that their occurrence is wholly unrelated to an animal's position in the zoological system. Group determination is not limited to blood corpuscles alone but it is possible in nearly all our body cells and body fluids. In sheep the Forssman substance is found in blood corpuscles but not in the tissues while in guinea-pigs it is present in the tissue but not in blood corpuscles.

Landsteiner and Levine discovered the antigens M and N in 1926 and Dr Friedenreich stressed at the scepticism of some authors that they are just as much blood groups as the original ABO system. The new MN system has long been classical and it has already occupied a place in forensic medicine. The additional factors P of the above authors and several more factors G, H and Q have also been discovered. It is still very difficult to assess the value of these findings but at any rate they show the presence of a great many group antigens in human blood corpuscles. Time may come when we may have the possibility in practice of a perfectly individual blood group diagnosis.

Dr Friedenreich next proceeded to speak of the rare group properties within the classical blood grouping system. He found a similar case like Crome—a mother M with a child N. Thorough re-examination by the speaker revealed the presence of a weak N factor, which was found to be an inherited defective N type in the family. This extremely rare group has been called N_2. It is analogous to A_2 and is recessive to N. The presence of a similar very weak antigen in the ABO system has led Dr Friedenreich to class another subgroup A_3. This gene A_3 is dominant to O but is recessive to both A_1 and A_2. Thus with the inclusion of N_2 and A_3 the complete system will have 15 genotypes and 8 phenotypes. The three classes of A corpuscles are not equal in all persons. A_3 members of a family differ from the A_3 members of another family in their anti A agglutinins. Similar serological peculiarities of a familiar nature occur within A_1 type also. It may be thus that the subgroups of A are really expressions of mutations in a relatively unstable gene.

The blood grouping phenomena occur by the blood forming cells in the bone marrow building up the respective antigens under the action of a blood grouping gene. In concluding Dr Friedenreich said that the serological methods reveal the most subtle difference in the composition of the organisms—far byond the scope of chemical methods.

—*S. S. Sarker.*

New Golden Figure from Columbia

In *Indian Culture*, *4*, 358, 1938, Dr H. D. Sankalia draws attention to a very interesting golden figure from Columbia, belonging to the Chibcha folks of the Cauca-tals and now housed in the Staatliche Museum für Völkerkunde, Berlin. The figure wears ornaments, has meditating eyes, and clearly shows the *ūrdhalinga*. As is well known, the last is a characteristic of the coins of the Indian god Siva (cf. *Science & Culture*, *1*, 588-89, 1936; *Ind. Cul.*, 2, 763-771, 1936), and dates back to the Chalcolithic Age represented at Mohenjo-daro. How it travelled to America and obtained a place in primitive mythology is a problem for the Diffusionists to solve.

—*G. L. Mukerjee.*

University and Academy News

Indian Physical Society

An ordinary meeting of the Indian Physical Society was held on Saturday, the 30th April, at 4-30 p.m., in the Physics Seminar, University College of Science, Calcutta, with Prof. D. M. Bose, Vice-President, in the Chair.

The undermentioned gentlemen were duly elected fellows of the Society:

(1) Dr C. W. B. Normand; (2) Dr N. Ahmad; (3) Dr H. J. Taylor; (4) Mr B. C. Mukherji; (5) Dr Swami Jnanananda, (Prague); (6) Mr Kartick Chandra Mookherji; (7) Mr Asoke Kumar Bose; (8) Mr Mrigankasekhar Sinha; and (9) Mr Haripada Sen.

The following papers were read:

(*i*) K. Banerji and A. Haque—Structure of aromatic compounds Part III—Benzophenone.

(*ii*) K. Banerji and A. Haque—Space group of Urea

(*iii*) D. M. Bose and P. C. Mukherji—On the origin of colour of paramagnetic ions in solution.

(*iv*) S. C. Sirkar and J. Gupta—On the heat capacity of a few crystals at low temperature.

(*v*) R. C. Majumdar—On the total reflection of Radiowaves in Ionosphere.

Dr A. K. Datta delivered an interesting lecture on 'Dispersion of supersonic waves in fluids.'

Royal Asiatic Society of Bengal

An Ordinary Monthly Meeting of the Royal Asiatic Society of Bengal was held on Monday, the 2nd May, 1938, at 5-30 p.m.

The following candidates were balloted for as Ordinary Members:—

(1) Maharaj Kumar A. C. Mahtab of Burdwan; (2) His Excellency The Right Hon'ble Lord Brabourne; (3) Mr Jacob Ruben Jacob; and (4) Nawab Sir Mohiuddin Faroqui.

The following papers were read:—

(1) M. B. Emeneau.—Kinship and Marriage among the Coorgs.

In this paper the author gives a description of the marriage rites and the kinship system of those Coorgs who live in the central portion of the province of Coorg, *i.e.* in Mercara and Virajpet, the district between these two towns, and in Nalknad to the west. No accurate ethnological account of these people has yet appeared.

(2) N. L. Bor.—Yano Dafla Grammar and Vocabulary.

An attempt has been made in this article to describe a little-known dialect spoken by one of the hill tribes in Assam, known as the Daflas. The Daflas inhabit the foothills of the Himalayas in Assam between the Bhorelli and the Khru rivers. As far as is known they live also northwards to the foot of the lofty snowcovered mountains known as the Se La range. The grammar is in the Yano dialect which is very different when spoken from the Tagen. A vocabulary is supplied in both the dialects. Difference in pronunciation and in the words between the Yano and the Tagen is noticed. A comparative list of Miri, Apa Tanang, and Dafla words is also given.

(3) S. N. Chakravarti. Development of the Bengali Alphabet from the Fifth Century A. D. to the end of the Mohammedan Rule.

In this article a systematic palæographic study of the development of the Bengali alphabet is

attempted. The Bengali alphabet itself was but a later local development from the Brāhmī Lipi which is undoubtedly the earliest syllabic alphabet of India. The Brāhmī alphabet developed through the ages of the Mauryas, the Śuṅgas and the Kshatrapas of Northern and Western India till by the time of the Kushāṇas it became divided into two distinct varieties, an Eastern and a Western. This paper deals with the Eastern variety only. The author has also attempted to solve the origin of the Indian system of notation.

After the reading of the papers, the following communication was made:—

M. Hidayet Hosain.—A Flying Machine in the 9th century A.D.

Abul Qāsim ʿAbbās bin Firnās who died A.D. 888, had invented a flying machine, a description of which is given by Al-Maqqarī, died A.D. 1632, a reliable historian. ʿAbbās bin Firnās attached a couple of wings to his body and getting on an eminence flew to a considerable distance but while alighting again on the place whence he had started he was hurt. The first attempt was not crowned with success but it appears from the account of Mumin bin Saʿīd, a contemporary poet, that the scientist was successful as an aviator and flew to great distances at a considerable speed. Among his other inventions worth mention are glass, and an instrument called *Minqālah* similar to the *metronome* by which time was marked in music without having recourse to notes and figures.

Indian Chemical Society

The Secretary of the Indian Chemical Society is glad to announce that in accordance with the recommendations of the Board of Examiners, the Council has awarded the Sir P. C. Ray 70th Birthday Commemoration Medal and J. M. Das Gupta Memorial Medal to Dr Nripendra Nath Chatterjee and Dr B. S. Srikantan respectively.

The Board of Editorial Correspondents for the Industrial and News Edition of the *Journal of the Indian Chemical Society* has been formed with the following gentlemen: -

Dr C. Barat; Dr Atma Ram; Mr B. B. Dhavale; Mr P. N. Das Gupta; Dr H. K. Sen; Dr J. K. Chowdhury; Dr S. Krishna and Dr K. G. Naik.

The first issue of the journal wi published

In accordance with the new rules as adopted at the last Annual General Meeting of the Indian Chemical Society at Calcutta, Prof. P. Ray and Prof. J. N. Ray, have been elected Honorary Editors. The following have been elected as members of the Board of Associate Editors for the Journal of the Society:

Dr P. K. Bose; Dr B. B. Dey; Dr P. C. Guha; Dr S. Krishna; Dr T. S. Wheeler; Dr S. S. Bhatnagar; Dr N. R. Dhar; Dr J. C. Ghosh; Dr S. S. Joshi; Dr J. N. Mukherjee; Dr B. C. Guha; Dr P. B. Sarkar; and Dr H. K. Sen.

Erratum

In SCIENCE & CULTURE. *3*, 572, 1938, col. 2, l. 5 *for* 400 crores etc. *read* 40 crores, etc

Letters to the Editor

[The Editor is not responsible for the views expressed in the Letters]

Experiments on the Synthesis of Degradation Products of Bile Acids, Sterols, etc.

The following experiments have been carried out with a view to synthesize the tricarboxylic acid $C_{13}H_{20}O_6$ isolated by Wieland and his co workers.[1]

Methoxy-acetone cyanohydrin was condensed with sodio-ethyl-cyano acetate and the resulting product was reacted in situ with ethyl- β-chloro-propionate, to yield diethyl -3, 4-dicyano—4-methoxy-methyl pentane—1, 3-dicarboxylate b.p. 194-200°/4 m.m., which on hydrolysis yielded—α-methyl—α-methoxymethyl- β-carboxy-adipic acid, as a gum. The triethyl ester b.p. 170-75°/4 m.m. of the above acid on treatment with sodium in benzene yielded 3, 5 dicarbethoxy—2-methyl—2-methoxy-methyl-cyclo-pentane—1-one b.p. 165-67°/4-5 m.m., which on hydrolysis yielded 3-carboxy— 2-methyl—2 methoxymethyl-cyclo pentane—1-one m.p. 117-19°. The corresponding ester of the above acid b.p. 130 32°/8 m.m. on being reacted with Grignard's reagent prepared from magnesium and 1-ethoxy—4-bromo pentane (prepared in the usual manner) has yielded a mixture of 1-hydroxy 1-(α methyl—δ-ethoxy butyl -3-carbethoxy 2-methyl -2-methoxymethyl-cyclopentane and the corresponding unsaturated compound.

On complete dehydration followed by subsequent hydrogenation, dealkylation and oxidation, the above compound is expected to yield the $C_{13}H_{20}O_6$ acid.

My best thanks are due to Prof. P. C. Mitter, M.A., Ph.D. for his advice and the keen interest he has taken during the progress of this work. My thanks are also due to Mr N. Ghosh for carrying out microanalysis of some of these compounds.

Palit Laboratory of Chemistry, University College of Science, Calcutta. — D. K. Banerjee.
16 5-38.

[1] *Z. Physiol. Chem.*, *134*, 276, 1924; *ibid.*, *216*, 91, 1933.

On the Electrodialysis of Serum with a new Diaphragm

In working out the conditions essential for the removal of electrolytes from serum without appreciable loss of anti-body in the serum, the writer has noticed that of the three types of diaphragms studied, cellophane, parchment and phenol-resin product, the last one gives best results. Thus a serum on dialysis in a chamber with parchment diaphragm gave only 800 I. U. after a period of 4 hours, whereas with the phenol-resin product membrane afforded a product of 1500 I. U. (International Units) under the same conditions.

It is peculiar that on subsequent dilution, the rate of fall in antitoxic units was different not only with different diluents but with the same diluent under different physical conditions.

The work is in progress.

Bengal Immunity Research Laboratory, Baranagore, Calcutta. — N. R. Chowdhury.
11-5-38.

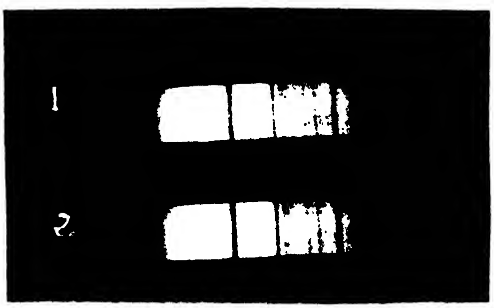
Absorption Spectra of Rare Earth Salts of Ranchi Allanite and Gaya Monazite

The region from Gaya through Hazaribag to Ranchi and Purulia is highly mineralized, and one occasionally picks up radio-active minerals. Even to the north of Gaya the hot springs of Rajgir in the district of Patna are highly radio-active.[1] Occurrence of radio-active columbite, with its analysis, was reported by me so far back as 1928-29.[2] Analysis of radio active allanite with an absorption spectrum given by the rare earth salts obtained from it was also published in 1932.[3] Since then I have had occasion to analyse allanite which extends from Ranchi to Purulia, an extensive area. Beryl and tantalite have also come under my notice. Tantalites have often proved to be columbites rather than tantalites. All these minerals have economic value and should be systematically sought for.

LETTERS TO THE EDITOR

In my paper on radio-active columbite I had mentioned that I had in my possession a few small bits of monazite said to have been picked up from Gaya district from near about where the columbite was found. The amount of thoria in it is about 5 per cent or so. There is substantial amount of oxides of columbium and tantalum in the monazite, lending support to the claim that this was picked up from near the columbite deposit.

In the course of my investigation I prepared some rare earth salts both from this monazite and from allanite above referred to. How closely the two minerals, monazite from Gaya and the allanite from Ranchi districts, resemble in their rare earth contents will be seen from the two absorption spectra.



The absorption spectra here depicted were taken with a Direct Vision Diffraction Grating Spectroscope attached to a quarter plate camera and adjusted for our purpose. A difference of 1000 on the tenth metre scale (Å. U.) corresponds to 6.6 mm. It is possible to identify the bands fairly easily. The light source was Pointo-light. (30 C.P.).

I reserve further and fuller details for future publication.

Bose Research Institute, N. C. Nag.
Calcutta.
19-4-38.

[1] Investigations on the Radio-Activity of Hot Springs at Rajgir, *Trans. Bose Inst., I,* 1931-32.

[2] Chemical and Electroscopic Examination of a Sample of Radio-Active Columbite from Gaya District, *Quaterly Jour. Geo. Min. & Metal. Soc. India, 2,* Pt. I, 1929.

[3] Radio-active Allanite from Bahea, Ranchi, *Malaviya Commemoration Volume,* 1932.

Absorption of Radio Waves in the Ionosphere

In the derivation of the Appleton Hartree formula for the propagation of radio waves through the upper atmosphere the motion of the electron in the electro-magnetic field of the incident wave is assumed to be subjected to frictional forces proportional to its velocity. The frictional forces may be thought of as arising out of the collisions between electrons and the heavier gas particles in the ionosphere. Since each collision tends to destroy the directed momentum of the vibrating electron it will cause absorption of energy from the incident radio wave. It is possible to make an estimate of the collisional frequency from suitable observations on the absorption of the radio waves "reflected" from the ionosphere. Such observations yield values of collisional frequency of the order of 10^7/sec. in the F layer and 10^5/sec. in the E-layer.[1] If plusible assumptions regarding the temperature and pressure at the E layer height be made, then it is found that the collisional frequency of the electrons with the heavier particles as calculated from the classical gas kinetic theory agrees with the collisional frequency derived from radio experiments.

Now recent investigations show that the collision cross-section of atoms and molecules with electrons may vary between wide limits, especially when the velocity of the electron is small. This is the so-called Ramsauer Effect. The agreement between the observed and calculated values (on the gas-kinetic theory) of the collisional frequency is, therefore, rather surprising and seems to be accidental. In view of the fact that the new quantum-mechanics furnishes us with a means of investigating the various collisional processes more rigorously, the whole phenomenon of interaction between electrons, ions and molecules in the ionosphere should be studied anew in the light of quantum-mechanics.

Investigations on some of the important collision reactions, such as the dynamical equilibrium between the ions, electrons, neutral particles and radiation, in the ionosphere have recently been made by Massey[2] and also by Tukada.[3] Though not pushed to a satisfactory degree of quantitative accuracy their work furnishes us with much useful information regarding the physical nature of many of the phenomena of the upper atmosphere. The elastic collisional processes responsible for the absorption of radio waves have not been considered by them. In the present note an attempt has been made to investigate the elastic collisional processes in the light of the new quantum mechanics. This has also

been done recently by Majumdar to which reference will be made later.

In the ionosphere we assume that there exist the following particles:

(1) Oxygen molecules, atoms or both.
(2) Nitrogen molecules.
(3) Positive ions—molecular and atomic.
(4) Negative ions.
(5) Free electrons.

The equilibrium ratio of the different constituents is a function of the height. We assume the following composition for the E-layer:[2]

(1) Neutral molecules	10^{13}/c.c.
(2) Free electrons	10^{5} ,,
(3) Positive ions	10^{7} ,,
(4) Negative ions . . . , . .	$9.9 10^{6}$,,

Generally we consider two types of collisions:

(*a*) Between electrons and neutral molecules or atoms.
(*b*) Between electrons and positive ions (molecular).

(*a*) *Probability of elastic collision between slow electrons and neutral molecules*—The theory of elastic scattering by molecules becomes very much complicated on account of the fact that the molecular field is not spherically symmetrical. Detailed investigation on the elastic scattering of slow electrons by sufficiently representative molecular field has been made by Stier[4] using spheroidal co-ordinates. It can be shown that with the spheroidal system of co-ordinates defined by

$$\varrho = \frac{r_1 + r_2}{d}, \quad \mu = \frac{r_1 - r_2}{d}$$

d—the internuclear distance

the Schrödinger equation for elastic scattering becomes separable with a molecular field of the type

$$V = V_c\ f(\rho)$$

$$\text{where } V_c = 2z\left(\frac{1}{r_1} + \frac{1}{r_2}\right) = 8z\frac{\varrho}{d(\varrho^2 - \mu^2)}$$

the coulomb field for the molecule,

and $f(\rho)$ is such that $V \cong V_c$ for $\rho \cong 1$

$V = 0$ for $\rho = \rho_0$

The criteria for $f(\rho)$ are

$$f(1) = 1, f'(\rho_0) \geqq 0$$
$$f(\rho_0) = 0, f'(1) \geqq 0$$

An expression for the total elastic cross-section can be obtained with this type of field by the method of partial cross-sections. The method consists in finding two solutions of the wave equation, one inside and the other outside the molecular boundary given by $\rho = \rho_0$; the phases δ_{ml} which must be added to the wave outside to make it continuous with the wave inside the molecule are then determined by equating the ratio of slope to function for the two waves. The cross-section for elastic collision is then given by the formula

$$Q = \frac{4\pi}{K^2} \sum_m \sum_l (2 - \delta_{om}) \sin^2 \delta_{ml}$$

$$K = \frac{2\pi m v}{h}$$

δ_{om} is the δ function such that

$\delta_{om} = o$ (m is not equal to o)

$\delta_{om} = 1$ ($m = o$)

J. B. Fisk[5] has calculated the elastic cross-section for collision of O_2 and N_2 by the above method for electron velocities from 0 to 40 volts. The result obtained by him is given in figs. I and II. The experimental curves obtained by Ramsauer and Brüche are also given for comparison. The theoretical curve agrees satisfactorily with the experimental curve. For 0.1 volt energy which corresponds to the average kinetic energy of the electrons in the E-layer the total elastic cross-section is found to be equal to 15 atomic units for O_2 and 20 atomic units for N_2.

Since the classical gas kinetic cross-section for collision may be taken as $\cdot 5 \times 10^{-15} \cong 17 \cdot 1$ atomic units we see that Q (gas-kinetic) is of the same order of magnitude as Q (quantum-mechanical) at these low electron velocities. We now see the reason why the collisional frequency between electrons and neutral particles as calculated by the classical gas-kinetic theory agrees with the experimentally observed value.

(*b*) *Probability of elastic collision between slow electrons and positive ions (molecular)*—Majumdar has recently considered a model ionosphere consisting of electrons and ions only, and has estimated the frequency of the second type of collision, *i.e.*, collision between electrons and ions. He obtains a high value for the collision cross-section for

the +ive ions and the collisional frequency values obtained by him are

$$\nu = 10^{2}/\text{sec. for the F-layer}$$
$$\nu = 8 \times 10^{2}/\text{sec for the E-layer.}$$

On the strength of these results he argues that the F-layer is completely ionized (since his value of the collision frequency between electrons and ions only agrees with the experimental value). For the E-layer, though his value is a hundred times less than the observed value, he suggests that the collision in the E layer is still between electrons and ions, because on account of the attachment of electrons to neutral molecules the observed electron density in the E-layer is much less than the positive ion density. In fact he contends that the positive ion density in the E-layer is about 100 times that of the electrons. With this assumption the collisional frequency becomes equal to 8×10^{4} for the E-layer and agrees with the experimental value—in order of magnitude.

It thus seems that if we accept Majumdar's hypothesis we are in a dilemma. The collision frequency as calculated quantum mechanically on the assumption of encounters between electrons and neutral molecules is of the same order of magnitude as that calculated by Majumdar on the assumption of encounters between electrons and ions only.

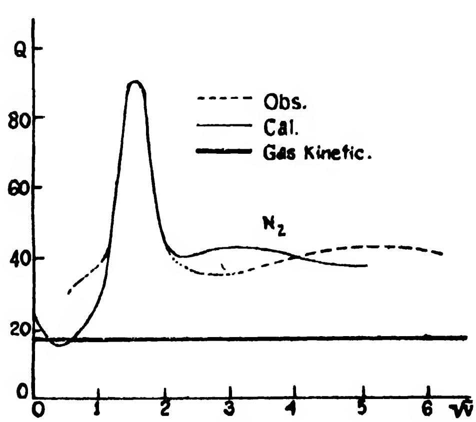


Fig. 1.

The question arises which of the two collisional processes is actually responsible for the absorption of the radio waves in the E-layer. If we examine the assumptions on which Majumdar bases his calculations we find that the reason of his obtaining the very large value of the collisional cross-section of the ions (so high in fact that it outweighs the effect of the number of neutral molecules exceeding that of the ions by a factor of the order of 10^{6}) lies in his simplifying assumptions regarding the ionic field.

Majumdar assumes a field of the type

$$V(r) = \quad {}^{z\,2} \quad {}^{-r\,b}$$

where, z is taken equal to unity

and b a constant equal to twice the average intermolecular distance $\sim 10^{-4}$ cm.

Now since $b >> r$ for all r where $V(r)$ is appreciable the field of the ion assumed by Majumdar becomes practically a spherically symmetrical coulomb field. Quantum mechanical treatment of scattering of electrons by such a field gives

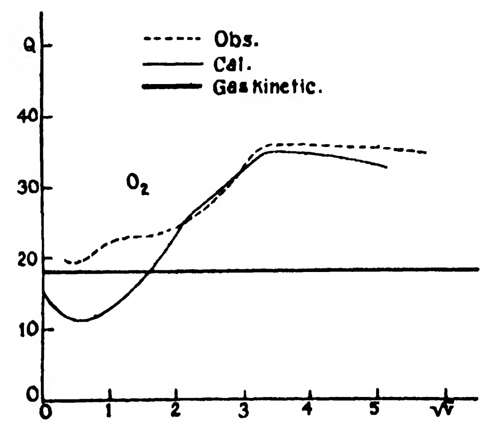


Fig. II.

results similar to the Rutherford scattering formula and the cross section tends monotonically to infinity as the electron velocity tends to zero. The extremely high value of the collision cross-section for the ions obtained by Majumdar seems to be due to the fact that the ionic field assumed by him agrees rather too closely to the coulomb field.

It is of course to be expected that the probability of elastic collision between electrons and positive ions will be larger than that between electrons and neutral molecules; but the ratio between the two cannot be so high as 10^{6} as is demanded by Majumdar's hypthesis.

It therefore seems reasonable to conclude that since the collisional frequency between electrons and neutral molecules as calculated quantum mechanically agrees with the observed values, the absorption of radio waves at least in the E layer is due primarily to elastic collision between electrons and neutral molecules.

My attention to this interesting problem was drawn by Prof. S. K. Mitra, to whom I express my grateful thanks for many helpful discussions.

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Calcutta.
24-5-38.

[1] Farmer and Ratcliffe, *Nature*, *135*, 618, 1935. Bailey and Martyn, *Nature*, *133*, 218, 1934.
[2] Massey, *Proc. Roy. Soc.* A., *163*, 542, 1937
[3] Tukada, *Report of Radio Research in Japan*, *7*, 121, 1937.
[4] Stier, *Zeits. f. Physik*, *76*, 439, 1932.
[5] Fisk, *Phys. Rev.*, *49*, 167, 1936.
[6] Majumdar, *Zeit. f. Physik.*, *107*, 599, 1937.

A Note on Longitudinal Waves in Degenerate Gas

Abstract.—Expressions for velocity of longitudinal waves in a degenerate and non-degenerate gas are found out and then an application is made to find the central density of the earth.

It is known that for any substance the adiabatic elasticity is $-V\left(\frac{dp}{dv}\right)_s$

The velocity of longitudinal waves is $\sqrt{E/\rho}$ where E is the adiabatic elasticity of the medium and ρ its density. Hence in the non-relativistic case the velocity is $\sqrt{\frac{5}{3}\frac{p}{\varrho}}$ and in the relativistic case it is $\sqrt{\frac{4}{3}\frac{p}{\varrho}}$

Using the values of pressure p as given by Kothari[1] we get the expression given in the Table for the velocity of longitudinal waves.

The interior of the earth is supposed to be a core of molten iron and therefore degenerate matter. Hence the velocity of seismic waves is $\left\{\frac{8\pi}{9m}\frac{h^2}{\varrho}\left(\frac{3\varrho}{8\pi\mu m_H}\right)^{\frac{5}{3}}\right\}^{\frac{1}{2}}$ to the first approximation.

On putting down the values of the constants we get the

$$\text{velocity} = 4.08\times10^{6}\,\frac{\varrho^{\frac{1}{3}}}{\mu^{\frac{5}{6}}}\ \text{cm/sec.}$$

The theory of pressure ionization gives

$$\mu^{\frac{5}{3}} = \frac{\mu_0^{\frac{5}{3}}}{1-\left(\frac{\varrho^*}{\varrho}\right)^{\frac{1}{3}}\left(1-\frac{1}{z^{\frac{5}{3}}}\right)}$$

where μ_0 is taken to be $\frac{56}{26}$ and z to be 26.

Now the velocity[2] of longitudinal waves at the centre of the earth is 11.4 km/sec. Taking the experimental value 7.86 gms/cm³ of ρ^* we get the central density as 9.49 gms/cm³ but if we take the theoretical value of ρ^* ($\log\rho^* = 1.8032$) we get the central density as 67.45 gms/cm³.

	Non-relativistic	Relativistic
Nondegenerate	$\left(\frac{5kT}{3\mu m_H}\right)^{\frac{1}{2}}\left\{1+\frac{\beta nh^3}{8(4\pi mkT)^{\frac{3}{2}}}\right\}$	$\left(\frac{4kT}{3\mu m_H}\right)^{\frac{1}{2}}\left\{1+\frac{\beta n}{512\pi}\left(\frac{ch}{kT}\right)^3\right\}$
Degenerate	$\left\{\frac{8\pi h^2}{9m\varrho}\left(\frac{3n}{8\pi}\right)^{\frac{5}{3}}\right\}^{\frac{1}{2}}\left\{1+\frac{5}{6}\left(\frac{8\pi}{3nh^3}\right)^{\frac{4}{3}}(\pi mkT)^{2}\right\}$	$\left\{\frac{8\pi ch}{9\varrho}\left(\frac{3n}{8\pi}\right)^{\frac{4}{3}}\right\}^{\frac{1}{2}}\times\left\{1+\frac{2\pi^3 mkT}{3}\left(\frac{1}{3nh^3}\right)^{\frac{2}{3}}\right\}$

where $n = \frac{\varrho}{\mu m_H}$

Further in any gas (degenerate or non-degenerate) $p=\frac{2}{3}E/V$ in the non-relativistic case, and since for an adiabatic change

$$TdS = dE + pdV = 0,$$

it follows that the adiabatic elasticity is $\frac{5}{3}p$. But in the relativistic case, since $p=\frac{1}{3}E/V$, the adiabatic elasticity is $\frac{4}{3}p$.

The Punjab University, F. C. Auluck.
Lahore.
9-5-38.

[1] Kothari and Singh—*Zs. f. Astrophysik*, March, 1938.
[2] B. Gutenberg and Richter—*Nature*, Feb. 26, 1938,

SUPPLEMENT

Government Scientific Departments and Learned Societies

[Since half a century ago, modern research was practically unknown in this country except for an attempt here and there in this direction. With the spread of Western ideas, however, a change was noticed everywhere, and the educated man on this side of the Suez felt keen interest in modern methods of research and concentrated his energy on it. Following the Western system, learned Societies were formed where original workers could meet one another, discuss their points of view and exchange notes. Soon we had quite a number of such bodies, one or two or even more dealing with a particular branch—most of these being all-India in outlook but provincial or local in their sphere of activity. The only all-India body, in the real sense of the word, at that time was the Indian Science Congress Association (for its history vide our editorial article of this month) which was formed to give a stronger impulse and a more systematic direction to scientific enquiry, to promote the intercourse of Societies and individuals interested in science in different parts of the country, to obtain a more general attention to the objects of pure and applied Science, etc." It held an annual meeting where papers were read and discussed. Its functions and aims are, however, different from those of the learnel Societies, just as the British Association for the Advancement of Science is different from the Royal Society. Hence the need for an Association all-India in character and composition remained. The Indian Science Congress Association, therefore, adopted a resolution in its 1934 meeting to this effect, and the National Institute of Sciences of India was founded in the following year, as the supreme organization in India with the other all-India scientific Societies cooperating with it.

Scientific Research in this country also owes much to the various Research Institutes and Government Research Departments. These have not only furthered the cause of original investigations in this country by actual cooperation with the Societies and private workers, but have also been themselves active centres of research for many years.

We give below short accounts of the important ones of these learned Societies and Government Research Departments, as far as they have been available to us. Some of these could not be included, due to want of adequate information. We hope however to publish them in future as soon as their histories are obtained.

Editor, SCIENCE & CULTURE]

Surveys and Scientific Departments

The Botanical Survey of India

The Survey of Botanical products of India began under the aegis of Government as far back as the nineties, when the operations were entrusted to (1) the Superintendent, Royal Botanic Garden, Sibpur, Calcutta, (2) the Director, Botanical Department of Northern India, whose office was at Saharanpur, (3) a member of the staff of the College of Science, Poona, and (4) the Government Botanist, Madras. The first named officer was given the additional and purely honorary designation of Director, Botanical Survey of India. He had however, practically no control over his associates except that he forwarded their annual reports along with his own to the Government of India.

In 1903 some reorganization took place and the officer at Saharanpur and Poona were replaced by the Economic Botanists to the Governments of the United Provinces and Bombay. The Government of India was impressed with the importance of botanical exploration and in 1911-12 on the recommendation of the Board of Scientific Advice the department of Reporter on Economic Products and the Industrial Section of the Indian Museum were amalgamated under the Director, Botanical Survey of India, who had already been provided with two Indian Assistants for systematic work, and thus came into existence the Department of the Botanical Survey of India.

The name of the Department gives a general indication of what sorts of work are carried on by it. Financial conditions have however limited the work to: -

(*a*) The care and improvement of the Public Gallery of the Industrial Section of the Indian Museum, which is now mainly an exibition of economic plants and their products.

(*b*) The collection, record and supply of information regarding all such economic plants and their products as do not specially belong to agriculture and forestry.

(*c*) Purely scientific work, mostly concerned with systematic Botany and the supplying of information in connection therewith.

(*d*) Publishing from time to time of valuable botanical theses written by eminent botanists under the caption "Records of Botanical Survey of India."

Besides the Economic court the Department maintains a good herbarium, a rich library and an excellent ledger section.

In this connection it may be noted that apart from botanical exploration and museum activities the department has to manage since 1919 the cinchona affairs of the Government of India embracing production and supply of quinine to the Provinces and States in Upper India.

The Geological Survey of India

The earliest geological work in India, between 1778 and 1818, was done by several surgeons of the Hon'ble East India Company, in addition to their duties.

"The Geological Survey of India had its origin in the desire of Government to have the coalfields systematically investigated" and in 1845 the Court of Directors of the Company in London sent out Mr. D. H. Williams as Geological Surveyor. Before he died of fever in 1848, he had explored the Raniganj. Ramgarh and Karanpura coalfields. While his successor was being sought, Dr. J. McClelland, Secretary of the Coal Committee, visited the Giridhi coalfield and submitted a "Report on the Geological Survey of India for 1848-49".

Dr Thomas Oldman, Director of the Geological Survey of Ireland and Professor of Geology at Trinity College, Dublin, came out in 1851 and was designated "Superintendent, Geological Survey". By the time of the Mutiny in 1857, he had gathered a staff of twelve, mostly Irishmen; the Survey had its office and Museum of Economic Geology at 1, Hastings Street, and the first *Memoir* had been published. When Dr. T. Oldham retired in 1876, after twenty-five years of service, he had established the Geological Survey with practically its present organisation, and with a high scientific reputation, although its officers had been engaged largely upon economic surveys and had suffered much from disease and hardship.

The Department increased steadily until, after the end of the War, the cadre stood at one Director, six Superintendents, twenty Assistant Superintendents, five Sub-Assistants, Chemist and Artist. Then came the retrenchment of 1931 and the Department lost a third of its strength. A little of this has been regained and the cadre now stands at one Director, four Superintending Geologists, twelve Geologists, one Chemist, eight Assistant Geologists, Curator and Artist. The Petrologist, Palaeontologist and Assistant Director in charge of the Headquarters office at Calcutta are selected from the Geologists for short periods and the requirements of Burma are met by lending three officers on foreign service. Its budget is under four lakhs. The office of the Survey includes a well-equipped chemical laboratory, a scientific library of some 80,000 volumes, and an art section dealing with photography, printing, and the drawing and reproduction of maps and illustrations. It also maintains four mineral, rock and fossil galleries in the Indian Museum.

The main duty of the Geological Survey of India is the investigation of the mineral resources of India. For this the first requirement is the geological map of India, upon the accuracy of which the solution of most geological problems ultimately depends. These maps are usually drawn on the scale of one inch to the mile, and when published with the reports, are reduced to quarter-inch or lesser scales. A general geological map of India is published on a scale of 32 miles to the inch, and detailed maps of coalfields and oilfields have been printed on scales of four inches to the mile and more.

Such maps enable prospectors to cut short their preliminary work and to start where the Geological Survey left off, ruling out of their operations large tracts of barren country. Though often negative, the

economic information given by these maps is none the less of the greatest importance.

During the survey of the country, mineral deposits are frequently discovered. Such discoveries are published without delay and all information not acquired confidentially is freely available to the public. It is not the aim of the Department to compete with the private prospector and consulting geologist, and its work normally ends at the exploratory stage.

The Geological Survey is freely consulted by the Central and Local Governments on mineral and engineering questions, such as

(1) The suitability of sites in hill-stations with regard to landslips, the means of preventing slips and of remedying any which may have taken place.

(2) The suitability of proposed railway alignments, both from a constructional aspect and with a view to tapping the mineral resources of the country.

(3) The suitability of sites for dams and canals with regard to the geological structure and porosity of the rocks.

(4) The prospects of obtaining underground water for towns, cantonments and railways.

(5) The suitability of rocks for building stones and roadmetal, of limestones for lime and cement-making, of clays for ceramic and refractory purposes, and of coals for industrial purposes.

(6) The belts of country likely to be affected by earthquakes, and the construction of buildings to withstand them.

For the public, full advice and all information not of a confidential nature is given without fee to those interested in the development of minerals in India, and the identification of minerals, rocks and fossils sent in by private observers is done without fee.

A duplicate collection of rocks, minerals and fossils is maintained from which exchanges are made with museums abroad, and specimens presented *gratis* to museums, colleges and schools in India.

The scientific and economic results of the Geological Survey of India are published in three series, as illustrated:

Memoirs, dealing in detail with a particular region or with a particular mineral of economic importance, and published when such an investigation is complete.

Records, published quarterly, consisting of shorter papers on stratigraphy, mineralogy, petrography and palaeontology. In the Records are included the General Report, the Annual Review of Mineral Production and the more extensive Quinquennial Review of Mineral Production, which gives full details of all mineral occurrences worked in India.

Palaeontologia Indica, descriptions by specialists of groups of Indian fossils, with numerous plates.

The scientific work of the Geological Survey is so intimately bound up with the economic, that it has for long been recognized how inadvisable it is to attempt to separate these two aspects of Geology. The apparently more academic questions are taken up side by side with the economic, to the mutual advantage of both, making the Geological Survey a really vital service to the mining, metallurgical and chemical industries of India. Though not directly a revenue-producing department, it has more than justified its existence by its marked though indirect effect upon income tax returns, royalties and dead-rents and other matters affecting the State Treasuries, as well as by its official and public utility in ways already detailed.

India Meteorological Department

Though provincial meteorological services were established in the Punjab and Northwest Provinces (1865), Madras (1866), Bengal (1867), the Central Provinces (1868) and in Bombay (1871), it was not till (1875) that these were consolidated under the Meteorological Department with Mr. H. F. Blanford at its head.

Mr. Blanford's immediate task was the adoption of a uniform method of observation and the collection and discussion of all data at a central place, Calcutta, where arrangements were also made for the standardization of all instruments used by the department. He also immediately increased the number of observatories from 77 to 94. Since then the number of observatories has been more or less progressively increasing, the total number of observatories at present being 332 departmental and 62 non-departmental, including those in Burma.

In 1928 the Head-Quarters were shifted to a permanent official home in Poona which was chosen on account of its being in the main path of the monsoon and of the various facilities for upper air research available there. This, together with the increase in scientific staff, has contributed much towards the ever increasing usefulness of the meteorological department.

The work of this department has steadily grown and consists at present of the following:--

(*i*) daily weather report for the public, (*ii*) upper air work, (*iii*) warning to ships regarding adverse weather in the Bay of Bengal and the Arabian Sea, (*iv*) heavy rainfall warning for coastal and in land stations, (*v*) issue of forecasts and weather reports to aviators, (*vi*) issue of seasonal forecasts, (*vii*) supervision of rainfall registration over the whole of India, (*viii*) seismological and magnetic work, (*ix*) solar physics work, (*x*) work on agri cultural meteorology, (*xi*) keeping of correct time and (*xii*) research on meteorological and other correlated items of work.

After the transfer of the Head-Quarters to Poona the daily weather telegram for the whole of India and Burma began to be issued from Poona itself. In April 1937 a separate meteorological service for Burma was formed, and from July 1937 Burma has begun to issue its own daily weather telegram for its area. At present, the daily weather telegram for the whole of India, excluding Burma, is issued from Poona, while four weather summaries for four different regions in India are issued: two from Poona, one from Calcutta and the remaining one from Karachi.

It was in 1912 that an upper air observatory was started at Agra under the supervision of Mr. J. H. Field. Gradually more and more pilot balloon observatories have been started in different parts of India. There are now 32 such observatories in the whole of India (Burma excluded).

This is one of the countries whose prosperity lies almost entirely on agriculture. Hence it is no wonder that tentative forecasts of monsoon rainfall were made by Wilson in 1874, by Eliot in 1878 and Blanford in 1882 to 1884. In 1886, however, the first forecast for the June-September rainfall for the whole of India was issued. Since then such forecasts called seasonal or long range forecasts, have continued to be issued every year. It appears worth remarking here that India is the first country to introduce official seasonal forecasts or "foreshadowings" and is the only country in which there has been an unbroken series of them for over fifty years.

At present there are over 3,000 raingauge stations in India, including Burma. The rainfall amounts measured at these stations are published in "The Daily Rainfall of India" and "The Monthly Rainfall of India." Seismic observations are taken at six observatories, namely Agra, Bombay, Calcutta, Hyderabad (Deccan), Kodaikanal and Rangoon. Magnetic observations were started at Bombay (Colaba) in 1840, but when the electrification of the city was started, the magnetic observatory was transferred in 1904 to Alibag on the coast to the south of and about 19 miles distant from Bombay. One may wonder what connection is there between magnetic observations and weather.

Eliot was greatly interested in the subject of solar physics and was instrumental in starting the Solar Physics Observatory at Kodaikanal, about 7,700 feet above mean sea level, a suitable place for solar observations because of the clarity of the mornings and the very few days in the year on which solar observations are not possible. It was here that J. Evershed confirmed Einstein's prediction regarding the shift of spectral lines in the sun, and more recently the staff there have discovered oxygen in solar prominences. Further work is being continued.

In recent years a considerable amount of work has been and is being done on meteorological and other allied subjects. It is not possible to include these in this short note. These will, however, be found in the Jubilee number of the Indian Science Congress to which reference may be made.

The Department publishes quite a number of periodicals [daily (4), weekly (1), monthly (1) and yearly (7)] and issues other occasional publications. For a complete list reference may be made to the Annual Summary of the Meteorological Department for 1936-37.

Indian Central Jute Committee

HISTORY: The information of a Central Jute Committee on the lines of the Indian Central Cotton Committee was originally recommended by the Royal Commission on Agriculture. In para 65 of their report they stressed the importance of this body for

the purpose of watching over the interests of all branches of the Jute trade from the field to the factory. The Government of India accepted this recommendation in principle but could not give effect to it mainly on account of financial stringency. The financial position having improved, they decided to set up a Central Jute Committee and announced its constitution and functions in May 1936.

CONSTITUTION: The Committee was constituted with the Vice Chairman of the Imperial Council of Agricultural Research as its President and the members consisting of the Agricultural Expert of the Imperial Council of Agricultural Research, representatives of the Government of India, three representatives of the Provincial Agricultural and Co operative Departments, eight representatives of Trade interests and eight of Agricultural interests. Another trade representative has since been added to the Committee which has brought the total number of members to 25. The Government of India decided that the Committee should be financed by an annual grant not exceeding 5 lakhs from the Central Revenues and that it should be registered as a Society under the Registration of Societies Act XXI of 1860. They appointed Mr. A. P. Cliff, I. A. S. (Bihar) as the first Secretary to the Commitee.

FUNCTIONS: The functions of the Committee are to undertake Agricultural, Technological and Economic research, the improvement of crop forecasting and statistics, the production, testing and distribution of improved seed, enquiries and recommendation relating to banking, transport facilities and transport routes and the improvement of marketing, in the interests of the jute industry in India. It has also to advise the Central and Local Governments on these matters as required.

The inaugural and first meeting of the Committee was held on the 9th and 10th February 1937, when the programme of work was decided upon. The second meeting of the Committee was held in August last to consider the actual starting of the work on the various schemes of research and enquiry into the various aspects of the Jute problem.

PROGRAMME OF WORK: The Committee has embarked on a very ambitious programme of research work embracing all aspects of the jute industry from cultivation up to the finished goods. Its primary objective is to get comprehensive, detailed, and accurate information on every aspect of the jute problem and to make this information available to every one concerned with jute so that on it the various interested parties can base both their policy and their immediate action. Growers can be guided as to how much and what kinds of jute to sow when the requirements of the mills in India and abroad are accurately estimated sufficiently in advance; while agricultural and technological research will provide the material for assisting them both in the growing and the preparation of the crop and in producing the right proportions of the different qualities needed by the world market. If the world requirements of jute products can be worked out and their trend accurately estimated sufficiently in advance, the mills will at any rate see clearly what quantities and qualities to manufacture and what possibilities there are in new developments. When complete and reliable detailed information is available to the Governments concerned, on marketing and transport, amounts and qualities required for world consumption, the range of prices from the grower onwards, those Governments will be able to see clearly where action is possible to improve matters in this or that section of the business and can then safely take that action because it will be based on accurate business facts and figures and not in theories or hopes.

RESEARCH SCHEMES: The enquiry into the Marketing and Transport of jute has already began and the Officers appointed for the purpose have started collecting the required data. For its agricultural research scheme, the necessary laboratory will be built at Dacca and plans and estimates are already prepared. The Committee will take up the research on the fibre side of the Technology of jute and will erect a jute spinning laboratory with facilities for the testing of fibre and yarn. The Director of the Technological Laboratories has joined. The other items of research programme of the Committee include the studying of present position of seed supply, improvement of the jute forecast and the collection of statistics and information as regards consumption in India and abroad of jute and its products of various classes. The Committee have also appointed special agricultural propaganda staff for the jute areas.

CONCLUSION: It is hoped that from this work will emerge a sound foundation of accurate and impartial knowledge. On this can then safely be built, by the various authorities concerned, the structures of sounder marketing, more economical transport,

adjustment of output in quantity and quality both of jute and its products to suit present and future world uses and requirements, that will ensure the regular and smooth disposal of a reasonable jute crop year after year, profitably to all concerned.

Indian Research Fund Association

This Association was constituted in 1911 with a sum of Rs 5,00,000/- set aside as an endowment for the prosecution and assistance of research, the propagation of knowledge and experimental measures generally in connection with the causation, mode of spread and prevention of communicable diseases. It can claim to be amongst the pioneers in organized medical research on a large scale and has been referred to by other countries in very complimentary language. Still better, it has been copied by several other nations.

The control and management of the Association are vested in a Governing Body, the President of which is the Member in charge of the Department of Education, Health and Lands of the Government of India. The Governing Body is assisted by a Scientific Advisory Board of which not less than three members have seats on the Governing Body. The Board examines all proposals for work in connection with the scientific objects of the Association and reports as to their importance and feasibility. The members of this Board are appointed for one year, but are eligible for re-election, and they have power to add to their number. The Director-General, Indian Medical Service, is the Chairman of the Board and the Public Health Commissioner with the Government of India is the Honorary Secretary. The membership of the I. R. F. A. is open to nonofficials Every donor of Rs 5,000/- is entitled to become a permanent member, while every subscriber of Rs 100/- per annum can be a temporary member.

The original Governing Body of the Association was until 1929 composed exclusively of officials, but in that year the Raja of Parlakimedi, having made the munificient donation of Rs 1,00,000/- to the Association, was appointed a life member. In the same year the Government of India also took into consideration the question of liberalising the constitution of the Governing Body and finally decided to enlarge that Body by including three representatives of the Indian Legislature, two representatives of Medical Faculties of Universities incorporated by law in India and one eminent non-medical scientist to be nominated by the Governor-General. As a result of further representations from the Universities and the Legislatures, the Governing Body of the Association was again enlarged in 1933 by the addition of one further representative of the Medical Faculties of Indian Universities, making 3 in all, whilst it was decided that the non-medical scientists should in future be elected by the Indian Science Congress Association.

In order to ensure the closest co-operation between workers and to prevent overlapping of effort, an annual conference of all India medical research workers is convened under the auspices of the Association. At this conference, free discussions are held on the work accomplished and on proposals for future work. The results of these discussions are available to guide the members of the Scientific Advisory Board in making their recommendations for the programme of the following year. The Conference and the Advisory Board generally meet in November/December and examine all the proposals for research work and recommend a scheme of research for the guidance of the Governing Body of the Association.

The results of the Association's researches are published from time to time in the Indian Journal of Medical Research and its Memoirs and the Records of the Malaria Survey of India, all of which are issued under the authority of the Association. These publications have now a firmly established position in the scientific world, and are obtainable from Messrs. Thacker Spink & Co., 3 Esplanade East, Calcutta, on payment. In addition, non-technical articles, based on the results of research, are issued periodically for the benefit of the general public.

Since its inception a great number of enquiries have been carried out under the auspices of the Association and great expansion of its activities has taken place from small beginnings. The main subjects under investigation are:—

Cholera, Bacteriophage, Malaria, Nutrition, Leprosy, Plague, Vaccine, Tuberculosis, Indigenous Drugs, Maternal Mortality, Helminthology, Medical Mycology, Dracontiasis and Filariasis Protozoal Parasitics, Cancer, Epidemic Dropsy, Kala-azar, and Blood culture.

Besides financing investigations which are being conducted by workers in its direct employment, the Association gives grants-in-aid to outside institutions and also to outside workers. Its expenditure upon

various medical research problems has for the last few years approximated to about seven to eight lakhs of rupees per annum. The Association supports the Malaria Survey of India, which now enjoys inter national recognition. As part of the activities of this organization and in commemoration of Sir Ronald Ross, intimate association with India, an experimental malaria station was opened in Karnal in January 1927 and is known as the Ross Field Experimental Station for Malaria.

In the early years of the Association an annual Government grant of Rs 5,00,000/- enabled it to finance enquiries and to accumulate a capital. It was this capital and the income derived from it which has helped and is helping the Association over the lean years after the year 1931-32 when the Government grant for medical research was discontinued.

The History And Work of the Survey of India

The first authoritative map of India was published by D'Anville in 1752, when the exploration of the then unknown India was still largely in French hands. It had been compiled from routes of solitary travellers and rough charts of the coast. The Survey of India may be said to have been founded in 1767—when Lord Clive formerly appointed Major James Rennell, the first Surveyor General of Bengal. Rennell's maps were originally military reconnaissances and latterly chained surveys based on astronomically fixed points, and do not pretend to the accuracy of modern maps of India based on the rigid system of triangulation commenced at Madras in 1802 and since extended over and beyond India. From these beginnings, this department has gradually become primarily responsible for all topographical surveys, explorations and the maintenance of geographical maps of the greater part of Southern Asia, and also for geodetic work.

A geodetic framework is essential in any large survey, but there are a number of other activities, all of these ultimately utilitarian, which can be suitably combined with it and the following are some of those which have been carried out in India. Precise levelling for the determination of heights are;

Tidal predictions and publication of Tide Tables for forty-one ports between Suez and Singapore;

The Magnetic survey;

Observation of the direction and force of gravity;

Astronomical observations to determine latitude, longitude and time;

Seismographic and meteorological observations at Dehra Dūn.

Indian geodesy has disclosed wide-spread anomalies of the gravitational attraction in the earth's crust, which have recently led to a reconsideration of the whole theory of isostasy. Systematic gravity investigations, which may be said to have been initiated in India, are now being carried out intensively in all civilized countries.

Topographical Surveys.- In the past this department used to carry out the large scale revenue surveys for most of India, and was still conducting this work for Central and Eastern India and Burma in 1905. An authoritative Survey Committee appointed by the Government of India considered the position in 1905. It was feared that a separation of the topographical and revenue surveys might result in a wasteful duplication of work and two overlapping but mutually discrepant systems of mapping. These objections were met by a ruling that the basis of both systems of survey should be identical and provided either by the Survey of India or under its supervision.

Subject to this principle the remaining revenue surveys were handed over to the provinces, and the Survey of India was enabled to concetrate its energies on a complete new series of modern topographical maps in several colours on the 1-inch to 1-mile scale.

This new series had been rendered necessary by the natural demand for more detailed information to be shown on maps, especially as regards the portrayal of hill features by contours, proper classification of communications and—more recently—air traffic requirements.

It was intended that this 1905 survey should be completed in twentyfive years, and then revised periodically every 30 years. Owing however to the war and more recent retrenchments, only about three fourth of the programme had been completed by 1937, in spite of the reduction of scale for the less important areas.

Although new surveys are carried out every year, covering from thirty to sixty thousands square miles —an area roughly that of England—the maps of a large part of the country are still over 50 years old,

printed mostly in black only, and have hill features shown by roughly sketched from lines or hachures; such changes in town sites, canals and communications as have been embodied in them have not been surveyed on the ground, but are entered from data gathered from outside sources.

Owing to the serious financial situation in 1931, the establishment of the department was severely cut down and its annual expenditure halved, in consequence of which the modern survey of India cannot now be completed before 1950.

Large Scale Surveys.—Surveys and records of international, state and provincial boundaries have always formed an important item of topographical work, and in recent years numerous Guide Maps have been published of important cities and military stations where the 1-inch to 1-mile scale is inadequate.

Miscellaneous.—While expending on topographical and geodetic work all funds allotted by imperial revenues, the department is prepared to undertake or aid local surveys, on payment by those concerned, such as

- Forest and cantonment surveys;
- Riverain, irrigation, railway and city surveys;
- Surveys of tea gardens and mining areas, with such control levelling as is necessary for these operations.

Administrative assistance is also given, and executive officers lent, in aid of the revenue survey of various provinces and states.

The Mathematical Instrument Office of this department assists all Government departments, as well as non-officials, by maintaining up-to-date instrumental and optical equipment and by manufacturing and repairing instruments which would otherwise have to be replaced from abroad.

Millitary Requirements and Air Survey.—The Department is also responsible for all survey operations required by the army, and is in a position to meet the rapidly increasing complexity of modern military requirements, especially in air survey.

In view of its high military importance, air survey work for civil purposes is receiving all possible assistance, and continuous research is being carried on in the latest methods of mapping from photographs taken from the ground and in the air.

The flying and photography for air mapping done by this department are at present carried out by the Royal Air Force or the Indian Air Survey Company, a commercial firm with headquarters at Dum-Dum.

Administration is in the hands of the Surveyor General under the Education, Health and Lands Department of the Government of India.

The Headquarters Office is at Calcutta under the Assistant Surveyor General, and there are four Directors, one for the Map Publication and other technical offices at Calcutta, and three for three of the five Survey of India Circles into which the country is divided; the other two Circle areas (covering Burma and South India) are administered personally by the Surveyor General, who, since the separation of Burma from India on 1st April 1937, continues to exercise administrative and technical control over the Survey of India party working there, pending the ultimate development by Burma itself of a topographical and Geodetic Survey Department.

Of the three Circle Directors, one also administers the Geodetic Branch at Dehra Dūn in addition to his topographical survey Circle.

Zoological Survey of India

FOUNDATION: As a result of the representations made by the Trustees of the Indian Museum, the Zoological and Anthropological Section of the Indian Mesuem was converted into a Government Department—The Zoological Survey of India—on July 1st, 1916. The following extract from a resolution of the Government explains the scientific functions of the newly created department:—

> "It will be the duty of the Zoological Survey to act as guardians of the standard zoological collection of the Indian Empire and as such to give every assistance in their power both to officials and to others, in the identification of zoological specimens submitted to them, arranging, if requested to do so, to send collections to specialists abroad for identification in cases in which no specialists are available in India. The Survey will also obtain the fullest possible information about the systematic and geographical zoology of the Indian Empire and will place this information at the disposal of inquirers. It will not, however, interfere in any way with private enterprise in zoological matters or with the scientific work of other Imperial or Provincial Government departments."

Several consequential and administrative changes were made at the time of the inauguration of the Survey and it started its career with a complement of 4 officers, one Director, one Superintendent and two Assistant Superintendents.

HISTORY:—In order to trace the history of this apparently young department one has to go back over a hundred years when under the auspices of the Asiatic Society of Bengal Brain Hodgson started faunistic investigations in the territories neighbouring Nepal. McClelland also carried out zoological studies, particularly on fish, but it was not till the appointment of Edward Blyth in 1841 as the Curator of the Asiatic Society's Museum that a large scale work on the fauna was begun. Blyth interested himself mainly in the vertebrate fauna of India and as result of his work the Society began to receive zoological collections from all over the country.

By 1856, the Society's collections had become too large to be accommodated in its own building and consequently the Government was approached to establish an Imperial Museum at Calcutta for which the Society's collections could from a nucleus. The Government agreed to the proposal six years later, but it was not till 1875 that the Museum building in Chowringhee was completed and the Asiatic Society's collections transferred to their new home.

Between 1875 and 1916 and under the directions of the Superintendents of the Indian Museum, notably Dr. J. Anderson, Mr. J. Woodmason, Lt.-Col. A. W. Alcock and finally Dr. N. Annandale, a magnificent collection of animals, in most of the larger groups, was got together in the Zoological Sections of the Indian Museum and a number of descriptive catalogues mainly on the marine collections obtained by the Surgeon Naturalists working on board the Survey Steamer "Investigator" were prepared and published. In 1907, the Trustees agreed to start two publications under the titles "Records of the Indian Museum" and "Memoirs of the Indian Museum" for the publication under the results of the zoological investigations of its officers and on its collections by outsiders. After the inauguration of the Zoological Survey of India these publications, in order to avoid great bibliographical inconvenience involved in any change of name, were allowed to continue to appear under their original titles.

The staff of the Zoological Survey of India at present consists of one Director and 5 Assistant Superintendents, one of whom is an Anthropologist. One more post of an Assistant Superintendentship has been sanctioned and is likely to be filled up in the future. Though the number of officers is now more than in 1916, the increase in work has been entirely out of proportion to the increase in staff. The recognition of the importance of Zoology in the elucidation of economic problems has brought in lot of work to the Zoological Survey of India during recent years.

Owing to financial stringency prevailing in the country in 1931, the Zoological Survey of India suffered very heavily, as the financial appropriation for the Department was reduced to almost 50%. Consequently many of its useful activities had to be either altogether stopped or considerably curtailed. There has since been a certain amount of revival in the work of the department, but it will take years before the department comes back to its old level. All the funds for the working of the Department are supplied by the Government of India; and in this respect the Zoological Survey of India is on an equal footing with other scientific departments of the Government of India, such as the Geological Survey of India, the Botanical Survey of India, etc.

As indicated above the main publications of the Department are the "Records" and the "Memoirs" but in recent years a new serial entitled "Anthropological Bulletins" has been started for the publication of matters relating to the Anthropology of India.

Among the general activities of the Department it may be noted that in recent years the Zoological Survey of India has been and is being more and more consulted and asked for advice regarding such widely divergent subjects as (1) the organization of sea-fisheries by the Government of Madras and the Bombay National History Society, (2) brackish water fisheries by the Government of Bihar and Orissa, (3) freshwater fisheries by the Government of the United Provinces and Burma, (4) the protection of Lizards by the Government of Bengal, (5) the Oyster fisheries in the Sundarbans by the Government of Bengal, (6) the distribution of certain mammals, particularly those useful in medical research work, by the Calcutta School of Tropical Medicine, (7) the biology of the filter-beds of the Calcutta Corporation Waterworks at Pulta, etc., etc. Vast collections are also received from institutions and individuals from all parts of the country for identification.

One of the main functions of the Zoological Survey of India is to look after and maintain in proper other

the collections in the Zoological Galleries of the Indian Museum. These public galleries at the present consist of a very extensive and up-to-date Invertebrate gallery, excluding the Insects and Arachnids, the latter being exhibited in a separate ante-room generally known as the Insect gallery; a small Fish gallery; Amphibian, Reptilian and Bird gallery; Large Mammal gallery; and the Small Mammal gallery. In these galleries the representative forms of all types of animals found within Indian limits are exhibited.

The Survey also looks after the very extensive Reserve Study Collections which form the basis of original work on Indian Zoology. The Reserve Collections are available for study to all *bonafide* students of Natural History and Anthropology.

Attention may also be directed to the very extensive library of the Zoological Survey of India, which contains books on all branches of Zoology and Anthropology and is undoubtedly the best library of its type in the whole of Asia. It is also open to all *bonafide* students and in recent years, to encourage zoological research in the mofussil, the Survey has started to lend books to recognized institutions.

The Archaeological Survey of India

The Archaeological Survey was established in 1870 with the two main objects of conservation and research and exploration. Three years later local surveys were initiated in Bombay and Madras. The work of these surveys, however, was restricted to antiquarian research, and description of monuments, and the task of conserving old buildings was left to the fitful efforts of Local Governments, often without expert guidance and control. It was in 1878 that the Government of India under Lord Lytton awoke to this deplorable condition and sanctioned a sum of 3¾ lakhs to the repair of monuments in the United Provinces, and soon after appointed a conservator who did useful work for three years. Then reaction set in, and this post and that of the Director-General were abolished. The first systematic step towards recognizing official responsibility in conservation matters was taken by Lord Curzon's Government, who established the seven archaeological circles that now obtain, placed them on a permanent footing, and united them together under the control of a Director-General, provision being also made for subsidizing Local Governments out of imperial funds, when necessary. The Ancient Monuments Preservation Act was passed for the protection of historic monuments and relics, specially in private possession, and also for State control over the excavation of ancient sites and traffic in antiquities. Under the direction of Sir John Marshall, Director-General of Archaeology (1902-31), a comprehensive and systematic campaign of repair and excavation was prosecuted and the result of it is manifest in the present altered conditions of many old and historic buildings and in the scientific excavation of buried sites such as Taxila, Pataliputra, Sanchi, and in the Indus Valley at Harappa in the Punjab and Mohenjo-daro in Sind. Measures have been taken to ensure the continuance of the researches in connexion with Mohenjo-daro and Harappa. The present Director-General is Rai Bahadur K. N. Dikshit, who succeeded Rai Bahadur D. R. Sahani in April 1937.

Learned Societies

Royal Asiatic Society of Bengal

The Asiatic Society of Bengal, as it was then called, was founded in 1784 by Sir William Jones. Its scope was defined in Sir William Jones' (who was also its first President) address in the following words: " The bounds of its investigations will be geographical limits of Asia and within these limits its enquiries will be extended to whatever is performed by man or produced by nature." One of the Society's first activities was the publication of the *Asiatick Researches*, of which twenty volumes came out between 1788 and 1836, when it ceased to appear due to financial difficulties. In 1905, the *Journal and Proceedings of the Asiatic Society of Bengal*, was first published, and of this 21 volumes have been issued. Another serial, of quarto size, was started at the same time, called the *Memoirs of the Asiatic Society of Bengal*, meant for the publication of larger articles or those requiring more elaborate illustrations.

One of the most important of Society's activities is the publication of the *Bibliotheca Indica*, a series of texts in Sanskrit, Persian, Arabic, and other languages, frequently also with translations.

The Society maintains a large library of scientific and philological publications, and the MSS. Section of it is particularly important in view of its rich and varied collections. It contains about 5,000 volumes of MSS. in Person, Arabic, Turkish, etc., 1,600 of

those in Sanskrit, a number of Burmese collections, etc.

The Council of the Society meets once a month regularly throughout the year and it holds its annual meeting in February. A Medical Section of the Society was started in 1906, in which papers on medical subjects are read and discussed in its monthly meetings. These papers are usually published in the *Indian Medical Gazette*, and only short abstracts of these are printed in the *Proceedings* of the Society. It must be added here to the credit of the Asiatic Society that the formation of the Indian Science Congress was in no small measure due to its efforts, and even to this day, it is closely associated with the Congress, and is responsible for the management of its work and the publication of its Proceedings.

Th Royal Charter was granted to the Society in 1936, and it is now called the Royal Asiatic Society of Bengal.

National Insittute of Sciences of India

The National Institute of Sciences of India was founded on the 7th January 1935, at a meeting held in the Senate House of the Calcutta University under the chairmanship of Dr J. H. Hutton, President, Indian Science Congress, in accordance with a scheme devised by the Academy Committee appointed at a meeting of the General Committee of the Indian Science Congress Association held at Bombay on the 3rd January 1934.

The purposes for which the National Institute was founded were:—

(a) The promotion of natural knowledge in India including its practical application to problems of national welfare.

(b) To effect co-ordination between scientific academies, societies, institutions and Government scientific departments and services.

(c) To act as a body of scientists of eminence for the promotion and safeguarding of the interests of scientists in India: and to represent internationally the scientific work of India.

(d) To act through properly constituted National Committees in which other learned academies and societies will be associated, as the National Research Council of India, for undertaking such scientific work of national and international importance as the Council may be called upon to perform by the public and by Government.

(e) To publish such proceedings, journals, memoirs and transactions, and other publications as may be found desirable.

(f) To promote and maintain a liaison between Science and Letters.

(g) To secure and manage funds and endowments for the promotion of Science.

(h) To do and perform all other acts, matters, and things that may assist in, conduce to, or be necessary for the fulfilment of the above-mentioned aims and objects of the Institute.

Membership consists of Ordinary Fellows and Honorary Fellows. The Institute started with 124 Foundation Fellows on its rolls, elected according to the scheme prepared by the Academy Committee. An election is held every year for the enrolment of new Fellows, by ballot. 26 Ordinary Fellows and 7 Honorary Fellows were elected in the first year, and since then ten Ordinary Fellows and four Honorary Fellows are elected annually. The total number of Ordinary Fellows at the end of the year 1937 is 151 and the number of Honorary Fellows is 13.

The administration and management of the affairs of the Institute is entrusted to a Council composed of the officers of the Institute—namely a President, two Vice-Presidents, a Treasurer, two Secretaries, a Foreign Secretary and other Members of Council to make up a total of 25. In addition, the Royal Asiatic Society of Bengal, the National Academy of Sciences, India, Allahabad, and the Indian Academy of Sciences, as co-operating Academies, and the Indian Science Congress Association each nominate an Additional Vice-President and one Additional Member of Council from the Fellows of the Institute. The Government of India will also in future nominate a representative on the Council from among the Fellows of the Institute.

The Institute issuses the following publications. The *Proceedings*, of which one volume is published each year, contains (1) Symposia, (2) the shorter papers on various scientific subjects read before the meetings of the Institute, (3) the President's Address, (4) Minutes of the Annual General Meetings and Ordinary General Meetings, (5) Annual Report, and(6) other business matters. Three volumes of the "Proceedings" have been published. The "Transactions" which are published in 4to size, contain longer papers

of a monographic nature on various scientific subjects. Eleven parts of the first volume of the "Transactions" have been issued up-to-date.

The Institute also publishes *Indian Science Abstracts*, which consists of an Annoted Bibliography of Science in India. Two numbers of this publication including abstracts of papers published in 1935 have been issued up to now.

Prof. M. N. Saha, F.R.S., is at present its President, and Prof. S. P. Agharkar and Dr A. M. Heron its Secretaries.

The office of the National Institute of Sciences of India is at present located on the ground floor of the premises of the Royal Asiatic Society of Bengal, 1, Park Street, Calcutta.

The Indian Academy of Sciences, Bangalore

The Indian Academy of Sciences, Bangalore was founded in 1934 with Sir C. V. Raman as the President and Prof. Narayan Rao and Rao Bahadur Prof. B. Venkatesachar as Secretaries.

The scientific activities of the Academy comprehend (1) meetings for the discussion of papers submitted for publication, (2) symposia on special subjects, and publication of the *proceedings*, which come out monthly in two parts, (A) physical and Mathematical Series, and (B) Biological Series.

Its headquarters are at Bangalore.

Sir C. V. Raman continues to be the President of the Academy, and Prof. C. R. Narayan Rao and Prof. B. Venkatesachar the Secretaries.

The National Academy of Sciences, India

The National Academy of Sciences, India, was first started under the name of the Academy of Sciences of the United Provinces of Agra and Oudh with its head quarters at Allahabad in January 1931 with Prof. M. N. Saha as its first President and Prof. A. C. Banerji of the Allahabad University and Prof. P. S. MacMahon of the Lucknow University as General Secretaries. Its aims among other things were the cultivation and promotion of science in all its branches, to publish a bulletin containing research work done on scientific subjects, to organize a science library and to hold meetings and discussions on scientific problems.

In view of the all-India character of the Academy it was renamed in 1936—the National Academy of Sciences, India.

The administration, direction and management of the affairs of the Academy are entrusted to a Council consisting of the President, two Vice-Presidents, a Treasurer, two General Secretaries, a Foreign Secretary, and nine other members of the Council. The presidentship is confined to Fellows only, the Vice-Presidentship to Fellows and Benefactors, while other places in the Council may be held by any member duly elected to that body.

The Academy is composed of Patron, Benefactors, Honorary Fellows, Fellows and Ordinary Members. The number of Honorary Fellows is limited by constitution to 30 only and that of Fellows to 150, the former are to be selected from among most eminent scientists or persons who have rendered service to the cause of science and the latter from among persons who have attained distinction in scientific work and who are also members of the Academy. The number of members on the rolls of the Academy was 217 in 1937 and the number of Fellows was 100.

The Academy before its metamorphosis into the National Academy of Sciences, India, used to publish Bulletins of the Academy of Sciences, U. P. In 1934 the Bulletins were converted into the Proceedings. From 1936 the Proceedings have been renamed as the Proceedings of the National Academy of Sciences, India, in accordance with the new status assumed by the Academy. The Proceedings are ordinarily issued four times a year, contain the papers communicated to the Academy and are edited by an Editorial Board consisting of specialists in different branches of science.

The Academy holds monthly meetings in which original papers are read and discussed. It holds an annual meeting ordinarily once a year in which the chief business is to elect office-bearers and Members of the Council and in which the General Secretaries present their report for the year on the working of the Academy.

The Academy is maintaining a science library consisting mainly of scientific periodicals which it gets free in exchange for its publication. The number of such journals is more than 160. Some journals are also subscribed. The library is open to the members of the Academy but non-members are also permitted to use it to their advantage for the Academy stands for the diffusion of culture and dissemination of knowledge.

Dr B. Sahni, F.R.S., is the President of the Academy for 1937, and Dr S. M. Sane and Dr P. L. Srivastava are the General Secretaries.

Indian Science News Association.

The Indian Science News Association was started in 1935, with the following main objects in view: (*i*) to popularize and disseminate the knowledge and progress of natural and cultural sciences; and (*ii*) to publish journals and books and organize lectures both in English and Vernacular in furtherance of the the objects set forth in (*i*).

The Association is housed in the University College of Science, 92, Upper Circular Road, Calcutta, through the kindness of the authorities of the University of Calcutta. Up till now its activities have been primarily concentrated in conducting a monthly journal of science, named, *Science and Culture,* which deals with all branches of natural and cultural sciences and, through its columns, attempts to fulfil the objects of the Association as set forth in (*i*). The journal is run on a non profit basis and the costs are defrayed by the funds of the Association raised through private donations, the life-membership fees and subscriptions.

Sir P. C. Ray is the President of the Association and Sir U. N. Brahmachari, Mr. S. P. Mookerjee, Dr. Baini Prasad and Dr. S. C. Law are the Vice-Presidents. Prof. M. N. Saha and Prof. S. K. Mitra are the Honorary Secretaries who are also *ex-officio* editors of *Science and Culture.* The editorial Board consists of Prof. J. C. Ghosh and Prof. B. C. Guha in addition to the two secertaries, and functions in collaboration with the Executive Council of the Association.

The editorial office of *Science and Culture* is at 92, Upper Circular Road, Calcutta. The Journal is of a semi-popular nature and is intended for the educated layman as well as the student and teacher of science. It enjoys considerable circulation throughout the length and breadth of the country and also a fair amount of foreign circulation. It receives some 58 journals (24 Indian, 34 Foreign), both Indian and foreign in exchange and these are kept in its office for consultation and perusal by the members of the Association and the subscribers. The journal is now in its third year and has thus far published 32 issues.

Indian Physical Society

The inaugural meeting of th society was held on the 29th September, 1934, in the hall of the Indian Association for the Cultivation of Science, Calcutta. At its first annual meeting held in January, 1935, it was decided to fix Calcutta as the head quarters of the Society for a period of three years. The administration and management of the affairs of the Society is entrusted to a Council composed of the President, four Vice-Presidents, a Treasurer, a Secretary and twelve other members representing different active centres of physical research and studies in India. The total number of fellows is nearly 120 and this includes eminent physicists from all parts of India.

The Society holds regular quarterly meetings where papers contributed by fellows are read and discussed. It is collaborating with the Indian Association for the Cultivation of Science in publishing the *Indian Journal of Physics* and arranges speedy publication of papers communicated to the Society in that journal. The Society also arranges public lectures to be delivered by specialists on recent developments of the various aspect of physics and also organizes symposiums on recent advances in physics. In carrying out the above programme of work the Society acts in close collaboration with bodies like the National Institute of Sciences, The Indian Association for the Cultivation of Science and the Indian Science Congress.

In its meeting held in 1936, the Mathematics and Physics Section of the Indian Science Congress recognized the Indian Physical Society as the body representative of the physicists in India.

The Indian Mathematical Society

The Indian Mathematical Society was started mainly through the efforts of V. Ramaswami Iyer under the name "Analytical Club" in 1907 with its head quarters at Fergusson College, Poona. It soon changed its name into "The Indian Mathematical Club" which was finally renamed the Indian Mathematical Society in 1911. Since 1916 it has been holding biennial conferences at different university centres with the object of stimulating members to produce original papers and of providing occasions for the members from all parts of India to get into personal touch with one another and discuss topics of common interest. In 1932 the Society celebrated its Silver Jubilee at Poona under the presidentship of Dr R. P. Paranjpye.

The Society has today on its rolls nearly 325 members and subscribers.

Publications. The Society publishes quarterly, two Journals (which are sent free to the members), *viz.,* (*i*) 'the Journal of the Indian Mathematical Society' which publishes only original papers and caters for the needs of workers in the field of Advanced Mathematics. (*ii*) "the Mathematics Student' which meets the requirements of humbler workers, whose main activities centre round teaching of Collegiate Mathematics, and also publishes 'News Items' with the object of keeping the readers in touch with one another, and with leading events in the Mathematical World in India and abroad.

The Society subscribes for nearly 70 important mathematical journals and sends them in circulation to such of the members as may desire to look into them, free of any charge, or postage. The standard books of reference and back volumes of journals in the Society's Library at Poona are also issued to members whenever required.

The Calcutta Mathematical Society

The Calcutta Mathematical Society was established in 1908 with Sir Ashutosh Mookerjee as the first President, with the objects of fostering and encouraging the study of mathematics in all its branches amongst the various sections of the people of India, of promoting the spirit of original research and and of publishing a periodical journal containing in brief an account of the proceedings of the meetings held and the papers accepted by the Society and read before it.

According to the present constitution the Council consists of a President, five Vice-Presidents (of whom at least one should be a non-resident member), and twelve other members (of whom at least two should be non-resident members). At present Mr B. M. Sen, Principal, Presidency College, Calcutta is the President of the Society.

The Society has four categories of members: "Honorary member, Life member, Ordinary Resident and Non-Resident members", the last category including all ordinary members living outside Calcutta.

At present the Society has 40 subscribers and receives 101 journals, proceedings and other publications of other learned societies, in exchange of the Bulletin of the Society.

The Society maintains a good library of its own, containing about 3000 volumes, situated at present in the University College of Science and Technology, Calcutta, which gives every facility for work, to the members as well as to persons interested in the study and research in Mathematics.

The Society has published 29 volumes of the Bulletin. All the Bulletins of the Society are printed free of charge by the Calcutta University Press.

The Benares Mathematical Society

The Benares Mathematical Society was founded in 1918 by a number of prominent mathematicians from different parts of India, headed by Dr Ganesh Prasad, D.Sc., then Principal of the Central Hindu College of the Benares Hindu University with the object of encouragement and promotion of research in the various branches of pure and applied mathematics. Many mathematicians of distinction of foreign countries were also associated with it as its Honorary members.

A President elected annually, a Treasurer and a Secretary administer the business of the Society. After the death of Dr Ganesh Prasad, its founder-President in 1935, Dr Laxmi Narain, D.Sc., of the Lucknow University and Dr Gorakh Prasad, D.Sc., of the Allahabad University were elected its Presidents.

The Society has published 17 volumes of its *Proceedings* almost one every year and has confined its publications only to special research papers of its members. A Board of Editors has been appointed this year and it is proposed to publish papers of other mathematicians as well. The Society has received in exchange of its *Proceedings* the publications of numerous mathematical societies of the world.

The Society has on its rolls about 100 ordinary members. It is proposed to locate it in a separate building erected in memory of its founder, Dr Ganesh Prasad, on the grounds of the Benares Hindu University.

It has published few text-books on mathematics and some of these have gained wide recognition in India and abroad. It helps researchers and their papers are criticized and published so as to bring them under the notice of all.

The Indian Statistical Institute

The Indian Statistical Institute was inaugurated on the 17th December, 1931 under the chairmanship of the late Sir R. N. Mookerjee, who became its first President. The objects of the Institute, as defined

in its memorandum, are comprehensive, and include the promotion of the study of pure and applied statistics as well as the encouragement of research and dissemination of knowledge of these subjects. The membership of the Institute is open to all persons, irrespective of sex, nationality, race, creed, or class.

The Institute is affiliated to the Royal Statistical Society of London, and assured of the cooperation of a number of Statistical Associations on the Continent. It is in touch with the Statistical and other departments of the Central and some Local Governmnets in India, with some important States, with many educational organizations, as also with such bodies as the Imperial Council of Agricultural Research, and the different Chambers of Commerce. It is therefore in a position to obtain statistical information in regard to a variety of subjects, or to put inquirers in direct touch with authorities capable of furnishing the desired information.

Sankhya, the Indian Journal of Statistics is published by Prof. P. C. Mahalanobis, with the cooperation of the Indian Statistical Institute.

There are three local branches of the Institute in Poona, Mysore, and Bombay.

The Indian Chemical Society

The Indian Chemical Society was estabilished in 1924 with Sir P. C. Ray as the first President. The object of the Society is to cultivate and promote the cause of chemical science and allied branches of learning by holding meetings to read and discuss papers of scientific interest, by arranging lectures on broad scientific topics, by co-operating with other organizations having similar objects and specially by publishing original memoirs in chemistry and allied branches of science in the Society's organ, *The Journal of the Indian Chemical Society*.

The management of the affairs of the Society is entrusted to the Council consisting of President, four Vice-Presidents, Hony. Secretary, Hony. Treasurer and two Hony. Editors and twenty ordinary members of the Council elected by the Fellows of the Society.

From 1924 to 1927 four issues were published annually. During the next two years it was issued as a bimonthly. The number of issues published annually was increased to ten from 1930. Since 1934 the Society has been publishing twelve issues annually. The adjudication of the publishable matter is entrusted to a Publication Committee consisting of ten members elected annually.

The Society has built up a fairly comprehensive reference library consisting of valuable journals of chemistry and allied subjects and dissertations on scientific subjects received in exchange for its own Journal. The Society is in terms of exchange with more than 145 scientific publications, which are issued from all parts of the world.

The Society gives research grants for carrying out original work when funds are available and awards two gold medals (the Sir P. C. Ray medal and J. M. Das Gupta medal) to junior research workers for excellence of work.

Since 1936 the Society has undertaken to supply to its Fellows at a nominal cost typewritten extracts or transcriptions from Journals and from other reference books that are in possession of the Society or are available in Calcutta.

Prof. J. C. Ghosh is at present the President of the Society and Prof. B. C. Guha, the Honorary Secretary.

The Society has got at present three local branches, namely at Lahore, Bombay, and Madras.

Institution of Chemists (India)

The Institution of Chemists (India) was founded in 1927 with Mr R. L. Jenko, then Chemical Examiner for Customs, as the first President. Its objects were the holding of meetings for the purpose of reading papers dealing mainly with industrial chemical subjects; and making arrangements for organized visits to factories likely to interest its members. The Institution brings out four times in a year its *Proceedings* in which the papers read are published together with summaries of discussion and comments thereon.

Its membership is about 150. Recently a branch of the Institution has been opened at Ranchi known as the Bihar Branch.

The Institution maintains an appointment register with a view to assisting chemists to secure employment and firms to secure the right type of men.

Mr N. N. Sen Gupta is the present President of the Institution.

Biochemical Society

The Bio-Chemical Society, Calcutta, which was founded in 1934, has been holding eight to ten meet-

ings every year. The *Proceedings* of the Society include short abstracts of the papers read, the names and addresses of all the members and the personnel of the executive committee as well as the outgoing secretary's report. The papers read during the last three years cover a fairly wide range embracing problems concerning vitamins, nutrition, hormones, enzymes, drugs, immunochemistry, bacterial metabolism, etc.

At present the total number of members is 51 and the activities of the Society have fully justified the expectation with which it had been started.

The Bio Chemical Society, Calcutta, has given a great impetus to bio-chemical research and its *Proceedings* have already attracted wide attention.

Society of Biological Chemists, (India)

This all-India organization, which has its headquarters in Bangalore, was started early in 1931.

The Society has been holding under the auspices of its Branches in different parts of India, meetings for the discussion of original papers and Symposia on subjects of bio-chemical and general scientific interest. Summaries of such papers and discussions are being published in the *Proceedings* of the Society, the first volume of which was published in December 1936. With increasing support from Branch Centres, it is hoped that the *Proceedings* might in course of time, form a useful forum from which a perspective of the bio-chemical work being carried on in the different parts of this country may be obtained from time to time.

The Society has got on its rolls 20 Honorary members, among whom are some of the foremost scientists in the world, and about 350 ordinary members, interested in different branches of the Biological sciences *e.g.*— medicine, agriculture, forestry, public health sanitation, industry etc. In addition, various scientific institutions, libraries and Government departments are subscribing to the Society's publications.

The affairs of the Society are managed by an Executive Committee consisting of a President, a Vice-President, a Treasurer, two Secretaries and 11 members representing the Branches of the Society at Bombay, Bangalore, Indore, Madras, Coimbatore, Delhi, Lahore, Calcutta, Allahabad, Ranchi and Patna. The Annual general body meeting is held usually at the place where the Indian Science Congress meets and during the Congress Week. The Society is considered to be one of the most active of the "specialist" scientific organizations in India.

Sir U. N. Brahmachari is the President, and Dr C. N. Acharya and Mr B. H. Iyer are the Secretaries.

Botanical Society of Bengal

The Botanical Society of Bengal was started in December 1935 with the objects of promoting the cause of Botany and safeguarding the interests of Botanists in Bengal.

The number of ordinary members is about 75, including many from outside Calcutta.

The Society holds ordinary general meetings, usually once in a month, in which papers are read and discussed. Among its other activities may be mentioned holding of popular lecture and excursions. The Council of the Society has undertaken the working out of a treatise on the "Flora of Calcutta and its suburbs".

The Bombay Natural History Society

The Society was founded on the 15th September 1883 by eight residents of Bombay. The founders met at the Victoria and Albert Museum, Bombay and constituted themselves the Bombay Natural History Society. They proposed "to meet monthly and exchange notes, exhibit interesting specimens and otherwise encourage one another".

It was always one of the objects of the Society to establish in Bombay a Natural History Museum, worthy of its tradition and of the city of Bombay. When, therefore, the Prince of Wales Museum was built, the Society's collections, which were rich and varied, were, according to an agreement entered into between the Trustees of the Museum and the Society in 1921, transferred at first to the main building and later in 1936 to a new wing expressly designed for the purpose. The greater part of the research collections, however, continue to be kept at the Society's rooms at 6, Apollo Street. The Galleries of the Natural History Section are, according to Mr S. F. Markham, who made a Survey of the Museums of India, among the best in the world and worthy of every attention.

Among other activities the Society has carried on various scientific surveys, among which the Mammal Survey of India, Burma and Ceylon, undertaken in

1911 and completed in 1923 may be mentioned. The scientific results of the Survey appeared in 47 papers published in the Society's Journal and the data accumulated provide the basis for the revision of Blanford's Volumes on Mammalia in the Fauna of British India Series which is now being undertaken.

The Journal of the Society is now in its 39th Volume, the first number having come out in January 1886. In addition, it has published various popular books on Indian Natural History.

His Excellency the Governor of Bombay is the President of the Executive Committee which controls the affairs of the Society. This is assisted by an Advisory Committee.

The total number of members in 1936 was 1,300 including 200 Life Members. Its membership extends throughout India, Burma and Ceylon, and includes residents in England and the Colonies of Europe and America; as also many kindred societies, museums and scientific institutions throughout the world.

The Royal Agri-Horticultural Society of India

The above Society was brought into being in 1820 largely, if not entirely through the endeavours of the Rev. William Carey. The objects were to promote and improve agriculture and horticulture in India in all its branches. Towards the fulfilment of its objects, the Society made free distribution of vegetable seeds, held annually agricultural exhibitions, mainly in Calcutta, and awarded large monetary prizes and medals for the best products of the show. It also held essay competitions on various allied subjects.

Keen members started branches of the Society all over the country, such as Lucknow (first in 1835), Madras, Dinapore, Bangalore, Burdwan, Meerut and Singapore, etc.

There are on its rolls some one thousand members at present. The Society maintains a free enquiry Bureau on matters connected with horticulture, and a valuable Library open to its members for consultation. Many of the volumes are rare and out of print.

The Society used to bring out its transactions and journals formerly. For the last 15 years, however, no journal has been issued and only an annual report is published.

It is located at 1, Alipore Road, Alipore, Calcutta.

The Geological, Mining and Metallurgical Society of India

The Society was founded in 1924 to fulfil among others, the following objects:

(*a*) To promote and encourage the study of Geology, Mining and Metallurgy, (*b*) to collect, publish and distribute information relating to Geology, Mining and Meallurgy, and (*c*) to protect the interests of persons interested in Geology, Mining and Metallurgy pure and applied in India.

At present the Society consists of 132 ordinary members, 45 associate members and 2 honorary members.

The Society publishes (*i*) The *Quarterly Journal* which contains only original articles on geology, mining and metallurgy and allied sciences (nine volumes have so far been published); and (*ii*) *Bulletins* containing discussions, reviews, symposium etc. on important subjects of general and scientific interest and specially with regard to mineral industry of India.

The Indian Psychoanalytical Society

The Indian Psychoanalytical Society which is affiliated to the International Psychoanalytical Association, was established on the 22nd January, 1922. The objects of the Society are (*a*) scientific discussions, (*b*) providing facilities for original work, (*c*) organizing lectures, and (*d*) making arrangements for translation into English and Vernacular the important works on Psychoanalysis.

The Society holds monthly meetings for reading and discussion of original papers on geology, mining and metallurgy and allied sciences.

The Society has established the following centres in India to organize meetings and excursions and similar other activities to be carried out by the local members. (1) Bangalore; (2) Madras; (3) Poona; (4) Hyderabad; (5) Benares; (6) Dhanbad; (7) Asalsol; (8) Digboi; (9) Rangoon; (10) Rajputana; (11) Jamshedpur.

The Society arranges many excursions to various industrial centres and factories and to places of geological, mining and metallurgical interest with a view to afford opportunities to the members to gather experiences

The Society has started a Library which is growing by receiving large number (about 100) of foreign scientific periodicals in exchange. The Library is housed at present in the Geology Department, Presidency College, Calcutta.

Mr. D. N. Wadia is the present President of the Society and Mr N. N. Chatterjee and Prof. S. K. Roy are the Secretaries.

The registered office of the Society is at present located in the Geology Department, Presidency College, Calcutta.

The Mining and Geological Institute of India

The inaugural meeting was held on the 16th January 1906 at the head quarters of the Chota Nagpur Mounted Rifles, Asansol, Bengal, in the presence of His Excellency Sir Andrew Fraser, Lieutenent Governor of Bengal. The Institute was registered in 1909 unler the Companies Act of 1882.

The scientific objects for which the Institute was established were to promote the study of and encourage and assist all branches of mining, geology, metallurgy and engineering in India.

At the end of October, 1937, the total membership was 407, made up of 305 Members, 54 Associates, 36 Subscribers, and 12 Honorary Members. Very recently a new grade of Student Associates has been created to encourage students to take an early active interest in their profession.

Since its inception 32 volumes of the Transactions, including 94 parts, have been published.

Meetings are held for the reading of papers and visits to mining, geological and metallurgical places of interest throughout the year, usually about once a month.

The head-quarters of the Institute is at present housed in the office of the Geological Survey of India, Calcutta.

Each year, gold, silver and bronze medals are presented for the best papers read before the Institute and published in the *Transactions* and reaching a prescribed standard, whilst a prize of Rs. 500/- is given by the Government of India for the best original paper.

At an Extra-ordinary General Meeting held in October, 1937, it was resolved that the name of the Institute be changed to Mining, Geological and Metallurgical Institute of India, and sanction of the Government of Bengal to this change is now awaited.

The Calcutta Geographical Society

The Calcutta Geographical Society inaugurated in July, 1933 by a small band of workers, has been founded with the object of supplying the need of a central organization for the increase and spread of geographical culture in Bengal. Its aims and objects among others are:—

(*i*) to promote and diffuse Geographical knowledge;

(*ii*) to foster a spirit of adventure and research in Geographical matters;

(*iii*) to encourage and help persons engaged in the work of Geographical research and the spread of Geographical knowledge.

The Society is trying to attain these objects by organizing geographical lectures and exhibitions; publication of a journal; encouragement of geographical research and travel and the convening of geograpical conferences.

The Society has been fortunate in enlisting the support of a number of distinguished men as patrons and has an efficient body of workers as its council of fanagement. Dr A. M. Heron, Director of the Geological Survey of India is its President and Mr D. P. Ghosh and Dr S. P. Chatterjee are its Secretaries.

The Society consists of ordinary members, student members, life members and honorary members. The number of ordinary members amounts to one hundred sixty and the student members ten.

From September, 1936, the Society has been publishing a bi-annual journal named *The Calcutta Geographical Review*.

The Indian Psychological Association.

The Indian Psychological Association, an all-India Association, was started in 1925 with the aim of (*a*) co-ordination of psychological research; (b) publication of psychological works in English and the vernacular languages and the translation of existing foreign works; (*c*) publication of a journal; (*d*) organization of lectures and scientific discussions; and (e) such other items as may be determined from time to time. The management of the Association is, at present, in the hand of a Central Executive consisting of the President, the Secretary and 7 ordinary members.

Lt.-Col. Berkeley Hill is the Present President.

The Association, being an all-India Association, has members from all the parts of India. The Association, at present, consists of Ordinary members and Student members.

The Association publishes quarterly *The Indian Journal of Psychology*, which first made its appear ance in 1926.

Besides publishing the Journal, the Association organizes public lectures and scientific discussions. The Association is at present located at 92, Upper Circular Road, Calcutta.

The Indian Psychoanalytical Society

The Indian Psychoanalytical Society which is affiliated to the International Psychoanalytical Asso ciation, was established on the 22nd January, 1922. The objects of the Society are (*a*) scientific liscussions, (*b*) providing facilities for original work, (*c*) organizing electures, and (*d*) making arrangements for translation into English and vernacular the important works on Psychoanalysis.

The Society possesses a library where primarily books of psychoanalytical interest are kept. The number of volumes at present is 155. Every member and associate member has the right to borrow books from the Library under conditions laid down in the regulations.

The Society meets often to discuss points of theoretical and practical interests relating to psychoanalysis. Papers read in the Society have been published in the *Indian Journal of Psychology*, and other journals.

The Society preserves a list of persons who after duly fulfilling all necessary conditions of the Indian Society and the International Association are eligible to practise psychoanalysis in India or abroad. The number of such persons is small. A Psychoanalytical Institute for imparting training to suitable persons was started by the Society in 1930. A Council of 6 persons elected by the Society regulates the working of the Institute. The President of the Society is in charge of the Psychological Clinic at the Carmichael Medical College and Hospitals, Belgachia.

The Head of the Department of Psychology, University of Calcutta, Dr G. Bose, has been the President of the Society since its inception. The Office and the library of the Society are located at 14, Parsi Bagan Street, Calcutta.

Anthropological Society

In the year 1920 the Anthropological Society of the Calcutta University was founded as a club under the kind patronage of the late Sir Ashutosh Mukerjee. The members of the club met from time to time to discuss matters relating to anthropological research and to read papers. It also extended its welcome to foreign scholars who came to Calcutta. Notably among them are Prof. E. von Eichstedt, Dr E. S. C. Handy, Prof. C. Tauber of Munich, Dr Boulnois, and Dr Meinhard of the Volkerkunda Museum, Berlin. In the year 1934 the club was formally reconstituted as the Anthropological Society of the Calcutta University.

The object of the society is to cultivate and pro mote the study of primitive people and in general to encourage research work in Anthropology. Regular meetings are held to read and discuss papers of scientific interest and lectures on interesting topics are also arranged. The funds of the Society do not permit of publication of the researches carried out by the members of the Society. They have been published independently in the form of books or bulletins from time to time.

The administration of the affairs of the Society is entrustel to a Council consisting of the President, Hony. Secretary and Treasurer, and the Hony. Asst. Secretary elected annually. An ordinary meeting is held each month in which original papers are read and discussed. All the meetings are held in the Anthropological Seminar, 35, Ballygunj Circular Road, Ballygunj, (Palit House).

Prof. K. P. Chattopadhyay is the present President and Dr P. C. Biswas, the Secretary.

The Physiological Society of India

The Physiological Society of India was inaugurated at a meeting held on the 15th of July 1935, in the Physiological Laboratory, Presidency College, with Prof. S. C. Mahalanobis as its President and Prof. N. C. Bhattacharyya and N. M. Basu as its Secretaries.

The total number of Members of the Society at present is sixty-two. There are also thirteen Student Members.

The management of the Society is entrusted to an Executive Committee, consisting of the Presilent, one Vice-President, the two Secretaries, the Assistant Secretary and the Treasurer, and sixteen elected Members.

The Society has not yet been able to fulfil one of its cherished ideas the publication of an Indian Journal of Physiology. The papers read at the meetings of the Society are now being published in various scientific journals, but the abstracts of these papers have been published each year in the *Proceedings* of the Society.

Since its inception to the end of last year sixteen General Meetings of the Society were held in which thirty three original papers were read and discussed, including some joint meetings of the Society and the Biochemical Society of Calcutta.

The Society in 1935 started an agitation for the creation of a Section in Physiology in the Indian Science Congress, through its Secretary Prof. N. M. Basu which was crowned with success and the first meeting of the Section of Physiology was held in Indore in 1936.

Although much remains to be done, the Society has undoubtedly succeeded in providing a meeting place for the discussion and criticism of problems of Physiology and Biochemistry and thus creating an interest in the subject and giving an impetus to further research.

Prof. S. C. Mahalanobis is the President of the Society and Dr B. Ahmad and Dr B. B. Sarkar are the Secretaries.

The Institution of Engineers (India)

The Institution of Engineers (India) came into being as the result of a general desire of engineers in India to form a corporate body which should safeguard their interests, provide means of exchange of views on engineering matters and a medium of expression of authoritative opinions on engineering problems of public interest.

The Institution was formally constituted as a corporate body on the 13th September 1920. The inauguration was performed by His Excellency Lord Chelmsford on 23rl February, 1921. The most outstanding event in the annals of the Institution was its incorporation by Royal Charter on the 9th September 1935.

The Institution is modelled on the lines of the Institution of Civil, Mechanical and Electrical Engineers of England, the special feature being that it combines in one the work of all the branches of Engineering.

The Council of the Institution is the Committee of the British Standards Institution in India. It also acts as the Indian National Committee of the International Electro technical Commission and of the World Power Conference. On it devolves the duty of obtaining the opinion of competent engineers of India in the matter of standardization of engineering materials.

The Institution has a building of its own erected on leasehold land 8, Gokhale Road, Calcutta, and also a Reserve Fund amounting to more than a lakh of rupees. There are Local Centres at Calcutta, Bombay, Madras, Delhi, Lucknow and Bangalore.

The rapid progress of the Institution may be gauged from the fact that the strength of its membership has increased from 138 in 1921 to more than 1,100 in 1937.

The examinations for corporate membership are recognized by the Government of India and most of the Provincial Governments as qualifying for recruitment to superior engineering services.

Examinations are held by the Institution once a year to test candidates for membership who do not possess the recognized eqempting degrees or diplomas.

The Institution publishes quarterly Bulletins and an annual Journal.

Bhandarkar Oriental Research Institute

The Institute was founded on the 6th July 1917, the 80th birthday of late Sir R. G. Bhandarkar. Its objects are to publish critical editions of texts and original works bearing on oriental antiquities, to provide an up to-date oriental library, to train students in the methods of research and to act as an information bureau on all points connected with oriental studies.

The valuable library of the late Sir R. G. Bhandarkar which he had already bequeathed to the Institute, was handed over after his demise by his executors to the Institute. The library of the Institute has also in its custody the unique collection of nearly 20,000 manuscripts formerly in charge of the Deccan College.

The Institute publishes a quaterly journal called *the Annals* of the Bhandarkar Institute. It has undertaken to bring out a critical edition of the *Mahabharata*. Since August 1927 the Institute has been conducting rggular M. A. Classes in Sanskrit and Ancient Indian Culture.

It is housed in a fine building near the hills behind the Home of the Servants of India Society, Poona.

The Bihar and Orissa Research Society

The inaugural meeting of the Bihar and Orissa Research Society was held on the 20th January, 1915. The Society's object is the promotion of research within the province on the lines of other such Societies, both in India and elsewhere, its main fields of research being (1) History, (2) Archaeology and Numismatics, (3) Anthropology and (4) Philology. The Society can lay claim to an unbroken record of achievement in its quarterly Journal, which is now in its twenty third year of publication. Many notable articles—Historical, Philological, Ethnological and Numismatic have appeared in its pages; and to students of Ancient Indian History more particularly (based as this is, so largely on inscriptions), the Journal is an indispensable work of reference.

The Society has been conducting for the past nineteen years a systematic search for Sanskrit manuscripts in Mithila and two volumes of a Descriptive Catalogue of Manuscripts in Mithila, have been published, and two more are in the press. An Oriya Pandit for some years prosecuted a similar search for palm leaf Sanskrit manuscripts in Orissa.

An event of outstanding importance has been the discovery in Tibet in 1935 by the Rev. Rahula Sankrityayana of nearly 200 Sanskrit texts. These texts embody Buddhist writings of the first ten centuries after Christ. Among their authors are Nagarjuna, Vasubandhu, Asanga and Dharmakirti. These manuscripts are in scripts of the 11th century onwards, and are in most cases the only Sanskrit originals known. The Research Society has arranged to publish these texts in an Oriental Series of the first importance.

From the Rev. Rahula Sankrityayana, too, came in 1933 a most valuable collection of 932 Tibetan books and manuscripts, which he has placed in the Society's library.

Ordinary meetings of the Society are held from time to time, as well as an annual general meeting, at which addresses or lectures are delivered by distinguished scholars.

The Society has a valuable library, containing over 6,000 volumes.

A handsome suite of rooms has been provided for the use of the Society in the Museum building, which was completed in the year 1929.

The Indian Institute of Science

Established in 1932 the Indian Research Institute has for its objects among others the dissemination of Indian Culture in all its varied branches on modern scientific lines, and awakening of a widespread interest in the magnificent cultural legacies and sacred literature of Ancient and Medieval India among the general literate of the present day. Out of a series of fourteen subjects, the Institute at present carries on publication of five only (*a*) Vedic, (*b*) Buddhistic, (*c*) Lexicon, (*d*) Fine Arts and Archaeology, and (*e*) Indian Positive Sciences.

Among the achievements of the Institute, the first and foremost is the publication of its journal, the *Indian Culture* which is published four times in a year.

It maintains a library and is trying to organize a popular section of it and a free reading room.

The Institute has opened a centre for propagation of its activities in Bologna (Italy) which is being conducted by Dr E. G. Carpani, PH.D., and which is named "Rappresentanza Scientifica Italiana" of the Indian Research Institute.

Sir M. N. Mukerji is its President and Mr S. C. Seal its General Secretary.

The Indian Research Institute

Though the late Mr J. N. Tata conceived the idea of founding an institute for the promotion of scientific and industrial research as early as 1889, it was not till 1911 that the Indian Institute was actually started with Dr Morris Travers as its first Director at Bangalore which was selected on grounds of congenial climate and richness in minerals. The Institute began functioning with four departments only: (1) Department of General and Applied Chemistry, (2) Department of Electro-technology, (3) Department of Organic Chemistry, and (4) Department of

Bio-chemistry. But all was not all right with the Institute, and Dr Travers resigned in 1914. The Government, in 1921, appointed a Special Committee under the Chairmanship of Sir W. J. Pope to make enquiries and recommendations regarding the working of the Institute. The Pope Committee submitted a very elaborate scheme of expansion which however could not be given effect to.

Dr (now Sir) M. O. Forster was appointed Director in 1922 and continued to be so till 1933 when he was succeeded by Sir C. V. Raman, whose failure as an administrator led the Irvine Committee (appointed in 1936 to enquire into the affairs of the Institute) divest the Head of the Institute of all administrative powers which now rest with the Registrar. The Irvine Committee recommended certain other changes both in the administrative and academic sides. The Indian Institute forms a big educational centre in this country and active research in some branches of Science, especially in pure physics and chemistry, is carried on. It failed to fulfil the objects of the founder who wished to make it a link between industry and pure science. The Irvine Committee has suggested ways and means as to how the Institute can best serve the purpose for which it stands, and the changes recommended by them are being gradually given effect to.

Indian Society of Soil Science

The Indian Society of Soil Science was established at a meeting held on the 3rd and 4th January 1935 in the Baker Laboratories of the Presidency College, Calcutta. The objects of the Society are,

(*a*) to cultivate and promote Soil Science and kindred branches of Science and disseminate the knowledge of Soil Science and its applications,

(*b*) to work in association with the International Society of Soil Science and to cooperate with other organizations having similar objects,

(*c*) to do and perform all other acts, matters and things that may assist in, conduce to, or be necessary for the fulfilment of the above mentioned objects, and for the purpose of the Society.

The administration of the Society is vested in a Council consisting of a President, two Vice-Presidents, Past Presidents as *Ex-officio* Vice-Presidents, the Treasurer, the Secretary and six ordinary members elected according to rules. The total number of members is 52 at present.

The Society does not publish any journal of its own. The Society holds three meetings in a year, the Annual meeting held at the same time and place as the Session of the Indian Science Congress, and two ordinary meetings held along with each meeting of the Advisory Board of the Imperial Council of Agricultural Research. In order to promote intercourse among workers in Soil Science and to undertake cooperative work on local problems the Society has recently adopted a scheme for the establishment of local Centres. One such centre is already doing good work at Indore. It is hoped to start similar centres in Calcutta and Delhi in the near future. Prof. S. P. Agharkar is Hon. Secretary of the Society and the office of the Society is located in the Botany Laboratory, 35, Ballygunj Circular Road, Calcutta.

Calcutta—Past and Present

Unlike many other important cities in India, Calcutta cannot boast of ancient historic associations or a glorious past extending over centuries. Barely three hundred years ago, when on the other side of the Ganges, Hooghly was flourishing as a trade centre and a prosperous city under the Portuguese settlers, on this side of the river lay a few scattered villages so insignificant that they find scarce mention in contemporary chronicles. In less than three hundred years the city of Calcutta has grown into what it is to-day. Where stood a few huts and hovels at that time, stands to day the city of palaces, the premier city in India and the second city in the British empire.

The city was founded in 1690 as an East India Company settlement and its rise and growth have been synchronous with the rise of English power in India. During the last two centuries, in the guidance of the destiny of India, Calcutta has played the most important role. In the expansion of English power in the country it has served as the nucleus. On the other hand for the last hundred years and more, in matters political, social or educational, her sons whether by birth or adoption, have always led the rest of India, and naturally all movements aiming at political, social or educational progress of the country had their origin and centre of activity in Calcutta. With just pride she can point to the contributions which her illustrious sons, Rajah Rammohan Roy and Keshab Chandra Sen, Sri Ramkrishna and Swami Vivekananda, Pandit Iswar Chandra Vidyasagar, Ramesh Chandra Dutt, Ananda Mohan Bose, W. C. Banerji, Surendra Nath Banerji, C. R. Das, Ashutosh Mookherjee, R. N. Mookherjee, J. C. Bose, P. C. Ray, Rabindra Nath Tagore and other members of that illustrious family, made within the brief span of one hundred years, to the cultural advancement of the country, to its art, literature, science, politics, commerce and industry.

Foundation and History of Growth

The origin of the name of Calcutta has not been satisfactorily explained. Probably its origin may be traced to the word Kâli Kshetra (seat of goddess Kâli). Prof. S. K. Chatterji the eminent Bengalee philologist however thinks that this was originally a place where shell lime was deposited for sale, and hence the name Kali-kātā. (*Kali* means shell lime and *kātā* means place).

The selection of the present site and the actual foundation of the city was made by Job Charnock, an agent of the East India Company. Towards the middle of the seventeenth century the English received from Prince Shuja, the viceroy of Bengal, a charter to carry on their trade in these parts on payment of a fixed sum annually. Hooghly was at this time the main trade centre, and on his way to and back from Hooghly Charnock several times halted at Sutanuti a growing village on the left bank of the river and he was so much attracted by the village and its surroundings that when later he was offered an asylum at Hooghly by the Nawab he refused the offer and decided to settle down on this side of the river. This place being nearer to the sea than Hooghly afforded better trade facilities and safe withdrawal in case of defeat in war. Also the situation made it comparatively secure from attacks by Marhattas and Moguls. Portuguese trade being on the decline at Hooghly, native traders and bankers had already begun to divert to this direction. In 1690 Job Charnock issued a proclamation inviting various nationalities to come and settle in the Company's zemindaries the three villages of Sutanuti, Kalikata and Govindapur. The Portuguese, the Armenians, the Hindus, the Moslems and others responded to the overtures of Charnock and thus began to grow up the city of Calcutta.

Charnock died in 1692. In his time little was done to clear jungles, construct roads or build houses in the city. The new agent Charles Eyre was a man of initiative and enterprise. During his administration the old fort was built, and brick-built houses were erected for the president and servants of the Company. Other European merchants also built their houses on the eastern side of the Fort and a fine settlement grew up with the present Dalhousie Square as its centre.

In 1717 Surgeon Hamilton who attended the Moghul Emperor at Delhi during his illness secured from him a *firman* authorising the English to purchase 38 villages near about the three villages of Govinda-

pur, Sutanuti and Calcutta. The land now acquired was about 2000 acres and the city began to increase yearly in wealth, beauty and riches.

Of infinitely great consequence to Calcutta and indeed to the whole of India were the events that followed towards the middle of the eighteenth century. After Siraj ud dowla ascended the throne of Bengal in 1756, open hostilities broke out with the English. On June 16, the Nawab's army reached Calcutta and in a few days were in possession of the Fort. When news of the fall of Calcutta reached Madras, an army to avenge the defeat was sent under Clive and Watson, who reached Calcutta in December, 1756. On their approach the Nawab's garrison evacuated the fort and a treaty was concluded with the Nawab. Shortly after war broke out in Europe between England and France and Clive captured the French possessions at Chandernagore. The French were allies of the Nawab and again an open rupture between the English and the Nawab followed. The subsequent happenings are well known events of Indian history. There were intriguers in the Nawab's capital who wished to depose him and set up Mir Jafar in his place with the aid of the English. After executing a secret treaty with the treacherous Mir Jafar Clive with his army reached the field of Plassey on June 23.1757, and the battle was won without much fight. Mir Jafar on ascending the throne gave the English Zamindary rights over Bengal. Lavish compensations were awarded to the Company and its officers, a part of which was utilised in rebuilding the city, constructing a new fort, a mint and other public buildings. This victory of the English contributed considerably to the growth of Calcutta. The English were from now the king-makers of Bengal and in real power, and Calcutta which was their headquarters prospered beyond measure. Splendid country houses sprang up in the suburbs and the banks of the Hooghly. But the heart of the city was still an agglomeration of palaces and hovels.

During the tenure of office by Hastings who succeeded Clive, the administration came to be centralised more and more in Calcutta and the city had a systematic growth. The following is an account of the city left by an eminent European who visited the place in 1803. "The town of Calcutta is at present worthy of being the seat of our Indian Government, both from its size and the magnificent buildings that decorate it. The citadel of Fort William is a fine work. The Esplanade leaves a grand opening on the edge of which is placed the new Government house erected by Lord Wellesly, a noble structure not unworthy of its destination. On a line with this edifice is a range of excellent houses. Chowringhee, an entire village of palaces, runs for a considerable length at right angles with it and altogether forms the finest view beheld in any city." From this time on the progress of Calcutta has been continuous. The Town Hall was completed in 1818. The foundation of St. Paul's Cathedral was laid in 1839. The two misses Eden, the talented sisters of Lord Auckland, started the famous Eden Gardens about this time. The Port Commissioners were instituted in 1870 to control the docks, jetties and landing stages. Many modern improvements of the fort have been effected by this body.

Arrangements for improvement of the city on a large and long drawn out scale by opening up congested areas, laying and improving roads, providing open spaces, creating cheap houses for the poor and carrying the city's limits farther, have been undertaken by the Calcutta Improvement Trust set up in 1912, and very good work in these directions have been done by that body in the last few years. Broad streets like Chittaranjan Avenue, New Park Street, Rashbehari Avenue etc., have been laid and a number of fine parks have been set up. In the southern part of the city an extensive lake has been excavated which serves not only as a beauty spot but has helped the growth of such healthy sports as rowing etc.

The most important addition to the city in recent times, during the viceroyalty of Lord Curzon, is the Victoria Memorial Hall which is undoubtedly the most magnificent building erected in India during the British rule.

Present Area, Population, etc., and Municipal Administration

The present area of the city including the municipal area, the Fort William, the maidan, the port and the canals is about forty-five sq. miles and the population nearly 12,00,000 (1931). If the south suburban area, Tollygunge and Howrah be included the total population is about 17,00,000. The population of the city in 1921 was nearly 9,00,000 and fifty years back it was 6,33,000. These figures show how rapidly the city has grown.

Little was done to improve the condition of the city till about the end of the eighteenth century. In 1794 under a statute the Governor-General began to appoint Justices of the peace for municipal administration and

the Justices set to work to improve the town. The elective principle was introduced in the municipal administration of the city when in 1876 the same was invested in a body of councillors two-thirds of whom were elected, the rest being nominated by the Government. The state of things remained practically the same till the passing of the Calcutta Municipal Act in 1923, which was sponsored by the late Sir Surendranath Banerji. The act has provided for far greater popular representation and control over municipal administration than before. The present Corporation consists of 75 elected councillors, ten appointed by Government and five aldermen elected by the councillors. The mayor and the deputy mayor are elected annually from among them selves. The Corporation appoints its officers and exercises a general control over the functions of these officers. The revenue of the Corporation in 1900 1901 was Rs 54,34,000. In a little more than thirty years this has increased five fold, the present revenue being nearly Rs 250,00,000. One of the most important services rendered by the Corporation in recent years is the spread of primary education among the poorer classes in the city. In 1923 the number of primary schools in the city was only 19. In the past few years more than 200 free primary schools have been started and maintained by the Corporation, which gives free primary education to 30,000 children.

Social Life of the City—New Religious and Social Reform Movements

Of all cities in India Calcutta has the most cosmopolition population. It is the meeting place of many nationalities and religions. Amongst the religions professed Hinduism claims the largest number of followers and next comes the Moslems. Christians form the third largest group. Besides these are Parsis, Jains, Buddhists, Shikhs and sprinklings of other faiths.

The necessity of better understanding between the two communities was felt for the improvement of the administrative machinery and real contact was started through the efforts of some sympathetic European scholars. The foremost among them was Sir William Jones who came to this country as a judge of the Supreme Court. He founded the Asiatic Society of Bengal and devoted himself to the study of Sanskrit with the help of Pandits. Colebrook, Wilson and others also came into a close touch with the native scholars to understand better their culture. In1800 the College of Fort William was started to train English civilians in the language and literature of the country. But it was mostly through teachers like Rev. Alexander Duff, David Hare, Derozio and Captain Richardson, who aroused a genuine interest for literary treasures and civilisation of the West in the minds of Bengalee youths, that bonds of real love and affection were established. At the same time through the activities of Christian Missionaries, many brilliant Hindoo young men embraced Christianity. But this was soon checked by the new religious movements within the Hindoo society itself.

The Western influence on Hindoo society indirectly gave rise to the Brahmo Samaj movement first started by Rammohan Roy in Calcutta about a hundred years ago. Rammohan was a vedantist and opposed to conventional methods of Hindoo worship of many gods and goddesses. He preached monotheistic doctrines of the vedanta and after his death his movement was taken up by Devendranath Tagore and later Keshab Chandra Sen did much to propagate the new faith among the enlightened Hindoos.

The conversion of some of the best young men of the country, however, had their reactions on orthodox Hindoo society and the appearance of saints like Sri Ramkrishna and his disciple Swami Vivekananda saved the Hindoo society from wreckage. Swami Vivekananda was an apostle of neo-vedantic movement in the country and this movement more than anything else awakened in the hearts of his countrymen a consciousness of their ancient religious culture and their spiritual heritage.

Simultaneously with these new religious movements, various social reform movements also were started. The abolition of caste restrictions and untouchability was strongly advocated by the pioneers of the Brahmo Somaj movement and later Swami Vivekananda too led a vigorous campaign against untouchability. The Temperance movement also was started in Calcutta under the leadership of Keshab Chandra Sen, Peary Churn Sirkar and others. At long last the Indian National Congress under the leadership of Mahatma Gandhi has paid proper attention to these social evils and recently vigorous attempts have been made to eradicate them; but the credit of initiating these movements in the country goes to the leaders of Calcutta society of the last century.

Educational Activities in the City

In the earlier part of British rule education in

the province was imparted mainly through indigenous schools, where Sanskrit, Arabic and Persian were taught, and in the city there were a large number of such institutions. Lord Macaulay who came to Calcutta as the first Law Member of the Governor-General's Council expressed his opinion in the famous minute of Feb. 2. 1835, strongly advocating the teaching of English in preferance to Sanskrit or Arabic to the natives. Some time before Rajah Rammohan Roy made similar proposals to Lord Amherst in an open letter. In spite of establishing Sanskrit or Arabic schools of the old type he pleaded for a more liberal and enlightened educational policy of the Government "embracing mathematics, natural philosophy, chemistry, anatomy, with other useful sciences, employing a few gentlemen of talent and learning educated in Europe, and providing a college furnished with necessary books instruments and other apparatus." In 1835, the Governor-General in Council resolved that henceforth all available funds should be employed in imparting to the native population a knowledge of English literature and science through the medium of English. Several schools on western models came into existence through private efforts about the same time. But the premier institution which served the purpose of imparting English education to young Bengal was the Hindoo College founded in 1817 through the enthusiasm of David Hare and Rajah Rammohan Roy. In 1823 the Government allowed it to stand on the ground acquired for the erection of the Sanskrit College building. The subsequent career of the College was glorious, its students later becoming pioneers of all movements in the country. In 1835 the College was taken over by the Government and its name changed into the Presidency College, which to this day is the premier educational institution in the province. A start to female education among the natives in the province was given by Drinkwater Bethune with whom collaborated some leading Indian gentlemen of the city. The Bethune College was started in 1850 which later developed into a first grade college.

Present Educational Institutions

Primary education in the city in mainly catered by a large number of tree primary schools run by the city Corporation. The Corporation has a scheme for the introduction of free and compulsory primary education in the city without levying any additional education cess. The number of high English schools within the city is 124 of which 24 institutions are for girls. Annually more than 5,000 boys are sent up by these schools for the matriculation examination of the Calcutta University.

In the city there are 15 arts colleges which impart instructions to more than 12,000 under-graduate students. There are three colleges exclusively for women students and two more colleges arrange seperate classes for women. In some other colleges co-education is allowed. The premier educational institution in the city is the Presidency College, which possesses a big library, well-equipped laboratories and a brilliant teaching staff. The St. Xavier's College, managed by the Society of Jesus, was established in 1860 and enjoyed a reputation for science teaching due particularly to the efforts of Father Lafont who was a pioneer of scientific education in Calcutta. The Scottish Church College is one of the best institutions managed by Christian missionaries and has done much for the spread of education among the Indians. The Sanskrit College is one of the earliest Government institutions founded in 1824 with the object of encouraging the study of Sanskrit. The Bethune College is the foremost girls' college in the province. The Islamia College was opened by Government in 1926 for the benefit of Moslem students. The other colleges in the city are run by public bodies or by different missionary societies.

These institutions impart instructions to undergraduates and are affiliated to the Calcutta University. Since its foundation in 1857 the main function of the University has been the conducting of various examinations and conferring academical degrees. Students from such distant parts as Lahore, Burmah or Ceylon were admitted to the examinations of the University. The University had no permanent habitation till 1873 when the Senate House was erected. Extensions of building accommodations have been made from time to time and the present University buildings include commodious structures such as Darbhanga Buildings, where the University offices are accommodated, the Ashutosh Buildings for post-graduate classes in arts, and two Science College Buildings which were erected by the princely donations received from Sir Taraknath Palit and Sir Rash Behari Ghosh. At present the University has territorial jurisdiction over the provinces of Bengal (excluding the town of Dacca), and Assam, and it has under its control 62 colleges and one thousand high schools.

Due to the initiative and far-sighted policy of the late Sir Asutosh Mookherjee, the greatest of all vice-

chancellors who adorned the University, it has turned from a mere examining body to an actual centre of learning and higher studies. The postgraduate teaching department which was opened in 1917 provides for a two-year course of teaching in arts and science subjects. At present the department has about 1000 students reading for the M.A. degree and 250 students reading for the M. Sc. degree. The teaching staff consists of 260 professors and lecturers, many of whom have attained international reputation by their depth of learning and scholarship. The University has a big library containing more than 100,000 volumes, and the departments of Physics, Chemistry, Botany, Zoology and Geology possess well-equipped laboratories.

Professional and Technical Education

The western system of medical education was introduced in Bengal towards the beginning of the nineteenth century. The Calcutta Medical College, the premier institution of its kind, was founded in 1835. Advanced medical training is at present provided by the Calcutta Medical College, the Carmichael Medical College, the School of Tropical Medicine and the All India Institute of Hygiene and Public Health. The colleges provide for a six-year course leading up to the M. B. degree. In addition there are three medical schools in the city which train students for the licentiateship examination. There are a number of hospitals attached to the Calcutta Medical College which can accommodate 700 beds and nearly 1200 outpatients are treated there daily. The Calcutta School of Tropical Medicine owes its inception to the labours of Sir Leonard Rogers and commenced work in 1921. Teaching in tropical medicine and research work in tropical diseases are conducted here. In the field of medicine research it has already established an international reputation. The All India Institute of Hygiene has been started recently. The cost of acquiring the site and to build and equip the Institute was provided by the Rockefeller Foundation. The primary object of the Institute is to bridge over the gulf between the results achieved by pure research and their practical application to the community. It is working in close collaboration with the School of Tropical Medicine.

The Bengal Engineering College is the biggest institution managed by the Government for imparting higher technical education. It has three departments, the Civil Engineering Department, the Mechanical Engineering Department, and the Mining Department. The most important private institution for technical education is the College of Engineering and Technology at Jadavpur. Sir Rash Behari Ghosh made a princely gift of Rs. 16,00,000 to this institution and was its first President. The institution is under the control of the National Council of Education and provides for teaching in mechanical, electrical, and chemical engineering.

Facilities for higher commercial education are provided by the Calcutta University and the Commerce department of the Vidyasagar College. There is a Government Commercial Institute which affords training of a practical character. There is a Government School of Art, where about 250 students receive training in Drawing and Design course and also undergo practice in lithography.

Learned Societies, Research Organizations, etc.

In addition to the various educational institutions which have been briefly discribed above the city is also the seat of a large number of research organizations and learned societies. Foremost among them and also the oldest literary and Scientific Society of the East is the Royal Asiatic Society of Bengal started in Calcutta in 1784, by Sir William Jones, under the patronage of Warren Hastings.

One of the Society's first activities was the publication of the "Asiatick Researches" twenty volumes of which were published between 1788 and 1836. The proceedings of the Society's monthly meetings appeared in a Journal. It also undertook the publication of *Bibliotheca Indica*, a series of texts in Sanskrit, Persian, Arabic and other languages with translations. The Society has a large manuscript library containing about 5000 volumes of Persian, Arabic and Turkish manuscripts, a larger collection (about 16000 volumes) in Sanskrit. The library of printed books is particularly rich in scientific and philological serial publications. The Society's rooms are adorned by many works of arts.

The Asiatic Society fostered the formation of the Indian Science Congress, which held its first session in the Society's rooms twenty-five years ago, under the presidentship of the late Sir Asutosh Mookherji. The Society is responsible for the management of the work of the Congress when not in session and publishes its proceedings.

The Indian Association for the Cultivation of Science

The Association was started through the efforts of Dr Mohendra Lal Sircar, M.D., in 1876 with the

avowed object of cultivation of science in all its departments both with a view to its advancement by original research and to its varied applications to the arts and comforts of life. Arrangements for lectures in various branches of physical sciences were made. This system continued to about the end or the first decade of this century, when gradually more and more stress was laid on research. Sir C. V. Raman when in Calcutta used to conduct researches in the loboratories of the Association and the discovery of the Raman effect was made here. Recently a professorship in physics after the name of the founder of the association has been created whose duty is to devote himself to original research. Students from all parts of India carry on research work in the laboratories of the Association. The Association publishes the Indian Journal of physics, an important organ for the publication of research work done by physicists from all parts of India.

Bose Institute

The Bose research Institute at Calcutta was founded by Sir J. C. Bose in 1917. Research scholars are admitted on condition that they devote themselves wholly to the prosecution of research. Investigations carried on here on the physiological mechanism of vegetable life have established the important generalisation of the fundamental unity of plant and animal life. The Institute also possesses well equipped physical and chemical laboratories where original investigations are being carried on.

Calcutta University

The importance of Calcutta as a research centre grew immensely after the inception of the post-graduate departments of the University, when opportunities were created for members of the teaching staff to carry on research in the arts and science subjects. Books containing researches in ancient Indian History, Epigraphy, Fine Arts, Economics, Anthropology, Pure Mathematics, History and in English literature have been published by the University. Researches in the classical languages, in vernacular literature, philosophy and in comparative philology have been systematically carried on and the large number of publication on these subjects bear testimony to the high qualities of these researches. The establishment of the University College of Science with its well equipped laboratories enabled many members of the staff to carry on original research and some of them have earned international reputation. A large number of research scholarships and Fellowships are awarded annually to meritorious students who devote themselves exclusively to original investigations.

Bangiya Sahitya Parishad

The Society was started with Ramesh Chandra Dutt as its first president, with a programme for the cultivation and improvement of the Bengali literature. It also encourages historical, archaeological, sociological and other studies and researches with special reference to this province. It undertakes the publication of original books and translations from the best books in Sanskrit, Arabic, English or other European languages, and collection of old Bengali manuscript and object of historical, archaeological, ethnological or literary interest. It also tends to foster the spirit of research in literary, scientific, historical and philosiphical subjects and publishes the results of these researches through the medium of Bengali, for which purpose the Parishad issues a quarterly journal. The library has a rich collection of 50,000 volumes and 5,000 manuscripts. There is also a museum, chiefly provincial in character, consisting of exhibits of historical and archaeological interest.

The Indian Museum

The Indian Museum owes its existence to the Asiatic Society. The Society first began to collect Ethnological, Geological and Zoological exhibits. The Indian Museum was started in 1866 when the Society's collections were transferred to the Museums building. The Museum is divided into five sections, the Archaeological, the Art, the Geological, the Industrial and the Zoological section. The archaeological collection is the richest in the East. There are antiquities from Mohenjo Daro, 5000 years old, and other relics dating from 3rd century B. C. The picture gallery contains a rich collection of pictures representing various schools of Indian painting.

The Imperial Library

This grew out of the Calcutta public library which was founded in 1835 and housed in the Metcalfe Hall in 1840. The Govt. of India acquired the entire building and the books of the library in 1901, and the re-organised library was opened to the public in 1903. It is the largest library in India and has done notable service to a number of scholars in India. Calcutta is also the headquarters of a large number of learned societies, most of them of an all India character. Accounts of their activities are published elsewhere in this journal.

Some past Presidents

OF THE

Indian Science Congress

Sir S. G. Burrard

Sir Leonard Rogers

Sir P. C. Roy

Sir Asutosh Mookerjee

Mr C. S. Middlemiss

Sir M. Visvesvaraya

Dr Nelson Annandale

Some past Presidents

OF THE

Indian Science Congress

Sir M. O. Forster

Sir C. V. Raman

Lt.-Col. R. B. Seymour Sewell

Sir J. C. Bose

Prof. M. N. Saha

Dr J. H. Hutton

Sir U. N. Brahmachari

Past Presidents of the Indian Science Congress

[In the following pages we publish brief accounts of the lives and works of the past presidents of the Indian Science Congress during the last 25 years. Lack of adequate information in some cases and consideration of space in some others have not enabled us to deal with them in greater details, though we believe that the brevity of the accounts does hardly any justice to the fascinating story of the eventful lives of those "foremost men of Science in India" who have presided over the Science Congress, in the past.]

Sir Asutosh Mookerjee, Calcutta (1914)

Sir Asutosh Mookerjee was born at Calcutta on June 29, 1864 and was educated first at the South Suburban School, Calcutta, and then at the Presidency College. He had an amazingly brilliant academic career. He was the first alumnus of the Calcutta University, who took his M.A. degree more than once in different subjects. In 1886 he was awarded the Premchand Roychand studentship, in Mathematics, his favourite subject, and in 1891 became the examiner of Master of Arts Examination in Mathematics. In 1888 he took his degree in law and joined the bar. He became Honours-in-Law in 1898 and a Doctor-in-Law the following year.

As a young worker in Mathematics Sir Asutosh attracted attention of the noted mathematicians of those days, and mathematics remained ever his passion. He was elected a fellow of the Edinburgh Royal Society (1886), and a member of many learned Societies, such as the London Physical Society (1887), Societe de Mathematique of Paris (1888), the Royal Irish Academy (1890), etc. Besides, he was the recipient of numerous honorary degrees from Universities and Academies.

His rise as a lawyer was phenomenal and he became a Judge of the Calcutta High Court (1904-1928). But great as he was as a lawyer and a scholar, he was greater still as an educationist. The Calcutta University as it exists today is his creation, and the establishment of the Post-Graduate Council in Arts and Science is entirely due to his efforts and guidance. He was the Vice-Chancellor of the University from 1906 to 1914 and again from 1921 till his death in 1924. Sir Asutosh will also be remembered for the valuable service he did to education in connection with the Sadler Committee which was set up to advise the Government on Secondary and University Education in this country and of which he was a member. It is not possible to deal adequately with the eventful and fascinating life of Sir Asutosh. No other individual has contributed to the cause of education, not only in Bengal but throughout the length and breadth of the whole country, more then he, and his name has always been a great source of inspiration to the educated in general and the educationist in particular.

Honours and titles came to him thick and fast. He was for many years the President of the Asiatic Society of Bengal. He presided over the first meeting of the Indian Science Congress in 1916. Sir Asutosh died at Patna on May 25, 1924, at the age of 56.

Surg.–Gen. W. B. Bannerman, Madras (1915)

William Burney Bannerman, who was General President of the Congress of 1915, was born in Scotland in 1858. He received his early education in Edinburgh and taking up medicine in that city obtained the degree of M.B.C.M. in 1881.

Bannerman entered the Indian Medical Service in 1888 and after eight years of military service including the Burma Campaign was posted to civil employment in the Madras Presidency. There he acted for some years as civil surgeon and later as Deputy Sanitary Commissioner. His interests lay largely in the scientific side of medicine and he kept in touch with the new developments at that time in the region of bacteriology and tropical diseases. His opportunity to become closely associated with practical work

on these subjects came in when he was appointed Superintendent of the Plague Research Laboratory in Bombay, of which Haffkine was Director-in-Chief. Bannerman undertook a reorganization of the manufacture of the Plague Vaccine in which certain difficulties had been encountered and his technical ability and organizing powers were shown by the institution of methods which made possible the production of the vaccine safely on a very large scale. When Haffkine's association with the laboratory ceased, Bannerman became Director and the name of the Institute was changed to the Bombay Bacteriological Laboratory. Its functions were extended to enable it to undertake all kinds of bacteriological work for the Bombay Presidency, and as it was the first large organized Institute of the kind in India it became a centre for research workers engaged in the study of a variety of problems. The classical work of the Plague Research Commission which proved the rat-flea cycle of transmission of plague and established the groundwork of our knowledge of the epidemiology of the disease was accomplished at the laboratory of which Bannerman was director. The body of research workers on other subjects which had been developed at the centre found in Bannerman a sympathetic supporter and a level-headed critic whose advice and assistance could always relied on. His own research work was carried out chiefly on the bacteriology of plague and its serum treatment during this period and he also extended his studies to snake venoms on which he published important memoirs.

Bannerman continued as Director of the Laboratory which is now known as the Haffkine Institute until 1911 when he was selected by the Government of Madras for the appointment of Surgeon-General of that Presidency. He continued in that appointment until his retirement in 1918. Returning to his native land he unfortunately lived only another six years and died in 1924.

Sir S. G. Burrard, Lucknow (1916)

Sir Sidney Gerald Burrard was born on August 12 1860. He was appointed to the Survey of India in 1884, and was Superintendent, Trigonometrical Survey of India from 1899-1910. He became the Surveyor General of India (1910-1919).

In 1901 Colonel Burrard's paper upon *Himalayan Attraction* was published at Derha Dun and in 1907, he in collaboration with the late Dr. Hayden, F.R.S., prepared the official book *On the Geography and Geology of the Himalaya Mountains and Tibet.*

Sir Sidney was awarded the Victoria Medal for Science by the Royal Geographical Society in 1913. He was elected Fellow of the Royal Society in 1914. In recognition of his abilities and services the Government conferred on him the titles of C.S.I. in 1911 and K.C.S.I., in 1914. He presided over the Indian Science Congress in 1916, held at Lucknow.

Sir Alfred Gibbs Bourne, Bangalore (1917)

Sir Alfred Gibbs Bourne, was born on August 8, 1859. He is the eldest son of Alfred Bourne, Secretary to the British and Foreign School Society. He was educated at the University College School, Royal School of Mines, and University College, London, of which he became a Fellow. He worked as an assistant to E. Ray Lankester (1879-85) and was engaged in research at Zoological Station, Naples, from 1883-85. In the latter year he came out to India as the Professor of Biology in the Presidency College, Madras. He then served in various capacities, as the Registrar of the University of Madras (1891-99), Botanist to the Government of Madras (1897-98), Director of Public Instruction, Madras, etc. In 1915 he was appointed Director of the Indian Institute of Science at Bangalore which post he held till 1921 when he retired.

Sir Alfred has made valuable contributions in Zoology and Botany which among others include his papers on Anatomy of Pelomyxa, Limnocodium, Chaetobranchus, Leeches, Earthworms, Rotifera, Pearly Nautilus, Scorpion Poison, etc.

He was elected a Fellow of the Royal Society. The Government in recognition of his valuable services to science and education, honoured him with C.I.E. in 1908 and K.C.I.E. in 1913. Sir Alfred Gibbs Bourne presided over the general body of the Indian Science Congress in 1917, held at Bangalore.

Sir G. T. Walker, Lahore (1918)

Born in 1868 Dr Gilbert T. Walker was at St Paul's School from 1881 to 1896, then going to Trinity College, Cambridge, where he had the wonderful opportunity to work under G. H. Darwin, J. J. Thomson, A. R. Forsyth, A. N. Whitehead and J. W. L. Glaisher. He owed much also to J. Hopkinson's insistence that in physical applications, though mathematics was a valuable tool, it was a bad master

—that it only provided the quantitative side of physics and was not a substitute for it. The College made him a Fellow in 1891 and shortly afterwards a Lecturer in Mathematics. In 1903 the Indian Government selected him to take charge of their Meteorological Department, and arranged for him to go to America, Germany and France, in order to learn as much as possible from the chief workers there and in England in solar physics, magnetism and seismology, as well as in meteorology.

On arriving at Simla in June 1903 Dr Walker found conditions in the Department such as few today have any idea of. His predecessor Sir John Eliot had no science graduate to help him. The quantity of work that Eliot got through was amazing; his daily average was at least thirteen hours, Sundays and weekdays; he had very little of the joy of discovery, for his energy was absorbed in checking figures, reading proofs and in the inevitable departmental routine. In those days science had little prestige: it was only after long effort on the part of Sir Gilbert that the pay of the Head Clerk in charge of the Simla office, with its computing as well as its correspondence, was made as high as that of the lowest grade of routine clerks in the Secretariat, men who addressed envelopes and licked stamps.

Of course the big problems which annually demanded solution was that of forecasting the monsoon. This was too complex for theoretical treatment, and an empirical knowledge of the actual relationships must be the only solid basis. This meant getting all the data handy and training the staff to work out the mutual associations by routine statistical methods. This foundation developed gradually during his twentyone years in India and has grown further during the ten years that he spent as Professor of Meteorology at the Imperial College to which he was appointed by Sir Thomas Holland in 1924. Opportunities there occurred of getting more insight into soaring and flapping flight, a subject which is of special interest in India.

Dr Walker was elected a Fellow of the Royal Society in 1904. He was the general President of the Indian Science Congress in 1918, held at Lahore.

Sir Leonard Rogers, Bombay (1919)

Leonard Rogers, son of Henry Rogers R.N., was born on the 18th January, 1868. He received his early education at the Plymouth College and later joined the St Mary's Hospital, University of London. He qualified for the conjoint medical board diploma in 1891 and the next year, passed with high honours the M.B.B.S. of the London University. Early in 1893, he was admitted to the Fellowship of the Royal College of Surgeons, England, and the same year, he accepted a commission in the Indian Medical Service. While still a student, he decided to devote himself to a career of research in tropical diseases and on coming over to India, he immediately took up the problem of the 'fevers' which were very prevalent in Bengal and Assam at that time. His first report on 'Epidemic Malarial Fevers of Assam (Kala-azar)' was published in 1897 and after 10 years of persistent work, he wrote his first book on *Fevers in the Tropics* (1908). As Professor of Pathology at the Calcutta Medical College, Rogers had unique opportunity of studying both cholera and dysentery in a hyperendemic area, and after several years of most painstaking and devoted work, he developed the present successful treatment of cholera, dysentery and liver abscess.

Appreciation of the highly important work carried out by Rogers was not slow in coming. In 1905, when he had barely 12 years service, Rogers was elected a Fellow of the Royal College of Physicians, a distinction which few members of the Indian Medical service obtained at so early an age. He was made a C. I. E. in 1911 and a Knighthood was conferred on him in 1914. He won the Maxon and the Fothergillian Gold Medal of the Royal College of Physicians and was made a Fellow of the Royal Society in 1916. He retired from service in India in 1920 and was appointed physician and lecturer to the London School of Tropical Medicine and the London Hospital for Tropical Diseases and was made the President of the Medical Board in the India Office. During his career in India and England, he contributed numerous scientific papers and wrote important books on tropital medicine, chief amongst which may be mentioned *Dysenteries—their Differentiation and Treatment, Bowel Diseases in the Tropics, Leprosy and Recent Advances in Tropical Medicine, etc.*

One of the outstanding achievements of Sir Leonard Rogers in India, which will keep his memory alive for a long time to come, is the founding of the Calcutta School of Tropical Medicine. The idea of establishing a research centre of tropical medicine in Calcutta definitely formed itself in his mind in 1910 and after working indefatigably for nearly 10 years, he achieved his object.

He was the general President of the Indian Science Congress of 1919, held at Bombay.

Sir P. C. Ray, Nagpur (1920)

Born in 1861, Sir Prafulla Chandra Ray began his education in the Hare School, Calcutta, in 1870. He passed the Entrance Examination in 1879 from the Albert School. While reading for his degree, he was secretly preparing at home for the Gilchrist Scholarship Examination which was an all-India competition, and his success in 1882 enabled him to proceed to Europe for higher studies in science. He graduated from the University of Edinburgh and obtained the degree of D. Sc. in 1888 on the basis of a thesis in organic chemistry. He was honoured in due course by the award of a special scholarship by the Gilchrist Foundation and of the Hope Prize Scholarship, and also by election as the Vice-President of the Edinburgh University Chemical Society.

He returned to Calcutta in 1888, and after a year of waiting he obtained the post of an assistant professor at the Presidency College, Calcutta. The doors of the Indian Educational Service, which was almost an exclusive preserve for Britons in those days, remained sealed to him, though persons with far inferior qualifications were holding high appointments as professors in the service. He keenly felt the injustice done to him because of his race and colour.

But he was determined to make the best use of his opportunities. He felt it to be his mission to create an enthusiasm for research in his students. A stream of research work began to flow out from his laboratory, which soon made him well-known throughout the scientific world. These embraced a wide field of inorganic chemistry, dealing mainly with nitrites and with complex compounds of mercury, sulphur platinum, etc. Brilliant though he is as a research worker himself, he believes that his greatest achievement has been the foundation of the Indian School of Chemistry and of the Indian Chemical Society of which he was the first President (1924-26).

After the retirement from the Presidency College in 1916 after full 28 years of active service, Sir Prafulla Chandra was persuaded by Sir Asutosh Mookherjee to be the Director of the Chemical Laboratories of the newly founded University College of Science, which post he held with great distinction till last July.

Great as he has been as a teacher and researcher, he has also proved a most successful man of action. He has been responsible for establishing many industrial enterprises, of which the creation of the Bengal Pharmaceutical and Chemical Works is the most remarkable. Unaided and with a capital of a few hundred rupees saved from his small salary, he began the preparation of pharmaceuticals at his own residence. In 1902 the Bengal Chemical and Pharmaceutical Works was converted into a limited concern with a capital of 2 lakhs of rupees, and today it has a capital of Rs 50 lakhs and boasts of having the biggest sulphuric acid plant in Asia.

It is said about Sir Prafulla Chandra that the patriot in him has prevented the fullest realization of his genius as a researcher and an industrialist. Indeed, the one passion in his life has been an ardent love for his motherland. He has preached from hundreds of platforms, " Researches can wait, industries can wait, but *Swaraj* cannot wait." This passion has been the dominating force in his life. Honours have come thick on him, three years ago he was elected an honorary fellow of the Chemical Society of London. He was the General President of the Indian Science Congress Meeting in 1920, held at Nagpur.

Sir R. N. Mookerjee, Calcutta (1921)

Born on June 23, 1854, in the village Bhabla (near Basirhat), 24 Parganas District, Sir Rajendra Nath Mookerjee had his early education at the London Missionary School, Bhowanipur, Calcutta, where he read up to the standard required for beginning the engineering classes at the Presidency College, Calcutta, the Sibpore Engineering College having not then been established. Though he could not complete his course for a degree in engineering, he had so mastered the principles of the subject that he rose to be a most successful engineer.

Sir Rajendra first started business as a contractor, and later joined Messrs. T. C. Mookerjee and Co. It is here that he made his mark as a sound businessman. He next joined Martin and Co., of which he later on became the senior partner. He gradually became the head of a great business organization, including the firms of Martin and Co., Burn and Co., the Indian Iron and Steel Co., and the Indian Standard Wagon and Co. As a mark of appreciation of his business abilities and services to the country,

the Government honoured him with a C.I.E. and made him in 1909 a " Captain of Industry in Bengal." He was made a K.C.I.E. in 1911 and a K.C.V.O. in 1922.

Sir Rajendra Nath presided over the Bengal Retrenchment Committee in 1923, and in the following year he served on the All India Retrenchment Committee. During 1925-26, he was a member of the Royal Commission on Indian Currency and Finance. He was also president of the Committee of experts appointed to advise the Government, regarding the Howrah Bridge. He was Chairman of the Board of Trustees of the Indian Museum at Calcutta, and a member of the Governing Body of the Bengal Engineering College. He was president of the Asiatic Society of Bengal (1924) and of the Institute of Engineers (India) (1921). He presided over the general body of the Indian Science Congress in 1921.

Sir Rajendra died in May, 1936, at the age of 82.

Mr Charles S. Middlemiss, Madras (1922)

Charles Stewart Middlemiss, C.I.E., F.R.S., B.A., F.G.S., F.A.S.B. was born in November, 1859, educated at Cambridge and came to India in September 1883 as an assistant officer in the Geological Survey of India; he retired from India in 1930 after completeing 47 years of active service in various branches of Indian geology. During the course of his work he had to visit almost every part of India, from Garhwal to the Kashmir Himalayas, Hazara, the Salt Range mountains, the Southern Shan States of Burma, Rajputana, several districts of South India and Ceylon. The geological literature of all these areas bear the stamp of his accurate and painstaking field work, while in some areas, *e.g.*, Kashmir, his researches recast completely the old ideas regarding the structure and stratigraphy of these mountains that existed prior to his time. Middlemiss's researches embraced many branches of geology besides stratigraphy, including micro-petrographic study of South Indian rock-types in days when the microscope was just beginning to be used as an aid to petrology; investigation of earthquakes, especially the Kangra earthquake of 1905; the study of the stability of mountain-slopes and other economic and engineering problems. Middlemiss was not a prolific writer, but up to 1915 he had published 31 notable contributions, among which his Memoir on the geology of the Sub-Himalayas of Kumaon and Garhwal is regarded as one of the classic works on Himalayan stratigraphy.

Middlemiss never sought academic honours or distinctions, but the value of his work was recognized by the Geological Society of London who awarded him the Lyell Medal in 1914. In 1921 he was elected Fellow of the Royal Society. An active member of Asiatic Society of Bengal since 1884, Middlemiss was elected a Fellow of the Society in 1912. In 1917 he was President of the Geology Section of the Indian Science Congress and in 1922 he was called upon to preside over the plenary session of the Congress held at Madras. The Government of India marked their appreciation of his scientific work by conferring on him the C.I.E. in 1915.

After his retirement from the Geological Survey in 1917, he spent 12 most active and profitable years in the service of the Kashmir State in organizing the State Mineral Survey and in initiating detailed field investigations of economic mineral deposits. A series of valuable brochures on the metalliferous and other mineral resources of the State has been the result of his fruitful labours in this field.

Though nearing 80 years, Middlemiss happily is still full of mental and bodily vigour and is keenly alive to the problems and puzzles of Himalayan geology, freely helping his colleagues of old with his kindly fatherly advice and suggestions.

Sir M. Visvesvaraya, Lucknow (1923)

Sir M. Visvesvaraya was born in September 1861 and was educated in the Central College, Bangalore, and the College of Science, Poona. As he secured the first place among the successful graduates in Engineering in the Bombay University Examination of 1883, he was appointed early in 1884 to the guaranteed post of Assistant Engineer in the Bombay Public Works Department. As an Engineer he served in the various administrative divisions of the Bombay Presidency, including Sind, until he rose to the position of Superintending Engineer and Sanitary Engineer to the Government of Bombay. This office he held for four years, during which period he prepared and submitted schemes for the water supply and drainage for a large number of towns. After his retirement in 1908 from the Bombay Government Service, his services were requisitioned by the Nizam Government to undertake the necessary protection works against the ravages created in the City of Hyderabad by cyclonic storms and floods. The next three years he was Chief Engineer to the Government of Mysore (1909-12) and in 1912 H. H. the Maharaja

of Mysore was pleased to appoint Sir M. Visvesvaraya as the Dewan, which office he held with great distinction for a period of six years. As the Dewan of Mysore, he effected vast improvements in the State which has become now one of the most progressive States in India mainly through his efforts. After his retirement from the Mysore Government Service in 1919, Sir M. Visvesvaraya served in various capacities.

Titles and honours came to him thick and fast, from both the Government and the public bodies. He is the author of a number of reports. Among his more important publications may be mentioned, *Reconstructing India* and *Planned Economy for India*.

He presided over the Indian Science Congress in 1923, held at Lucknow.

Dr Thomas Nelson Annandale, Bangalore (1924)

Dr Thomas Nelson Annandale or, as he styled himself in later years, Nelson Annandale, was born in Edinburgh on the 15th of June 1876, and educated at the famous Public School at Rugby, where he rose to the head of the school and at Balliol College, Oxford, graduating in 1898. From 1902-1904 he held a research fellowship in Anthropology in the University of Edinburgh and was awarded the degree of Doctor of Science in 1905 for his work in the Malay Archipelago as a member of the Skeat Expedition.

He came to India in 1904 as Deputy Superintendent of the Natural History Section of the Indian Museum under Lt.-Col. A. W. Alcock, the Superindentent, and on the latter's retirement in 1907 succeeded him as the Superintendent. The title of this post was changed in 1916 to that of the Director, Zoological Survey of India, and he occupied this post till his death in 1924.

Even as an undergraduate Annandale spent several vacations in Iceland and the Faeroe Islands collecting materials which, after some preliminary reports, in *Man, Proceedings of the Royal Society of Edinburgh*, etc., were collected in a book entitled, '*The Faeroes and Iceland: a study in Island Life*' (1905). In 1899 he went as a member of the Skeat Expedition to the Malay Peninsula, and repeatedly travelled in that country during the years 1901 to 1903 in company with Mr. H. C. Robinson. The results of the Expedition were published in 1903-1907 as a series of reports on the zoological and anthropological results of the expeditions under the title *Fasciculi Malayenses*.

As the Superintendent of the Indian Museum Dr Annandale worked hard for the improvement of the administration of the Indian Museum and was not only successful in getting the whole administration remodelled, but obtained considerable increase in the staff of the Zoological Section. It was due to his continuous efforts that Zoology was placed on a footing of equality with Geology and Botany, and what so far was merely the Zoological and Anthropological Section of the Museum became established as one of the great scientific research departments of the Imperial Government henceforth called the Zoological Survey of India.

Annandale was first and foremost a student of animal ecology and, therefore, a field naturalist, but as the head of a great Museum he had perforce to be a taxonomist, though even as such he was not what is generally termed a "mere systematist. His own systematic work ranged over an unsually wide field. Freshwater Sponges, Coelenterates, Polyzoa, Mollusca, Marine Cirripedes, Insects, Fishes, Batrachia, Mammalia, etc., were all taken up by him at one time or another, and the large list of his published papers bears full testimony to the pioneer work which he did in all these sections.

He was a very active member of the Indian Science Congress Association from its very start and of the Asiatic Society of Bengal; the latter institution owes a great deal of its rejuvenation to his short term of presidentship. Twice he was the President of the Zoology section and in 1924 the general President of the Indian Science Congress. Just before his death his name appeared on the list of those nominated by the Council of the Royal Society for election as a fellow of the Society, but unfortunately his formal election as a fellow had not taken place before his sudden death occurred on the 10th of April 1924. He was made a Companion of the Indian Empire in recognition of his services to Indian Science.

Sir M. O. Forster, Benares (1925)

Sir Martin Onslow Forster born on the 8th November 1872, was educated at Finsbury Technical College and then at Wurzburg University, where he came in contact with the "galvanic" personality of Emil Fischer who left his indelible impressions on him, and whose memorial lecture he was fittingly called

upon to deliver by the Chemical Society, London, in 1920. He was the Granville Scholar of the London University in 1899 and later he occupied with distinction the post of Assistant Professor of Chemistry at the Royal College of Science. In 1915 the Longstaff medal of the Chemical Society was awarded to him, in fitting recognition of his contribution to chemistry.

Besides being a chemist of great repute, he exhibited his organizing abilities and social virtues by serving the Chemical Society, London, as its treasurer (1915-22) and hon. secretary (1904-10), and the Indian Science Congress Association as its president in 1925. The highest recognition of his scientific and administrative abilities was his appointment as the Director of the Indian Institute of Science, Bangalore, in November 1922. He held this post for over a decade with great distinction both in point of social harmony and academic efficiency. This is specially praiseworthy in consideration of the disquieting atmosphere at the Institute both before and after his regime.

He has made outstanding contributions to the chemistry of the triazo compounds and of compounds of the camphane series, totalling over a hundred papers, most of which have been characterized by a high order of accuracy and critical outlook.

Among his various public addresses his Streatfield memorial lecture delivered recently in England and his Presidential Address to the Indian Science Congress at Benares in 1925 mark him out to be a rare combination of an eminent scientist and a great literary scholar.

Sir Albert Howard, Bombay (1926)

Howard was born on December 8, 1873 and educated at the Royal College of Science, London, and St. John's College, Cambridge, of which he became a Foundation Scholar. He took First Class Honours in Natural Science Tripos in 1898, his B.A. in 1899 and M.A. in 1902. He was appointed Mycologist and Agricultural Lecturer, Imperial Department of Agriculture for the West Indies (1899-1902) and Botanist to the South-Eastern Agricultural College, Wye (1903-5). Howard served as the Imperial Economic Botanist to the Government of India during 1905-24. Subsequently he became Director of the Institute of Plant Industry, Indore, and Agricultural Adviser to States in Central India and Rajputana (1924-31).

Howard's scientific contributions are considerable, and his publications include *Crop Production in India* (1924), *The Development of Indian Agriculture* (1928), *The Application of Science to Crop Production* (1929), *The Waste Products of Agriculture* (1931). He has also published numerous papers on botanical and agricultural science in various journals.

As a recognition of his scholarship and meritorious service, the Government of India made him a C.I.E. in 1914 and conferred on him a knighthood in 1934. He was elected a Fellow of the Linnean Society and Honorary Secretary of the British Science Guild. He presided over the general body of the Indian Science Congress in 1926 held at Bombay.

Sir J. C. Bose, Lahore (1927)

Born on November 30, 1858, Sir Jagadis Chandra Bose was educated first at the Hare School, Calcutta, and then at the St. Xavier's College, Calcutta, whence he took his B.A. degree. Thereafter he sailed for London with the intention of studying medicine; but, due to ill health, he gave up the medical course and entered the Christ's College, Cambridge, where he won a Natural Science Scholarship. He obtained the Cambridge degree in Natural Science Tripos and the London degree of B. Sc. about the same time.

On his return to India, he was appointed officiating Professor of Physics in the Presidency College, where he proved himself to be such a successful teacher that he was confirmed in his post in the Indian Educational Service. It is here that he started his research work in wireless communication, which was engaging the attention of the scientific world at the time. Then followed a long fruitful career of scientific investigations, which began with physics, passed on to the response of plant tissues under different kinds of stimulation and of their similarity with that by animal tissues, and finally ended in plant-physiology.

Bose's name reached far and wide. He was invited by the International Congress of Physics arranged at the Paris Exhibition in 1900, where he gave and demonstrated the results of his investigations on the "Response of Inorganic and Living Matter." This established his reputation as the explorer of an entirely new field in science.

Honours began to pour on him from all parts of the world, and Bose was invited to lecture on the results of his investigations, and demonstrate them at various intellectual centres, in the East and the West.

He was elected a Fellow of the Royal Society in 1920. He was a member of the International Committee of Intellectual Cooperation of the League of Nations, and a member of many learned societies. He was the recipient of honorary degrees from numerous universities. He presided over the Indian Science Congress in 1927, held at Lahore. Bose died on November 23, 1937 of heart-failure. (For a fuller account of his life and scientific works, *vide* our December 1937 issue pp. 341-48.)

Dr John Lionel Simonsen, Calcutta (1928)

John Lionel Simonsen, born on 22nd January 1884, received his education in Manchester Grammar School and University. After graduation in 1904, he secured the Schuck Research Fellowship in 1906 and his doctorate in 1909.

His chemical contributions lie mostly in the field of Terpenes amongst which the isolation of α-thujene, *dl*-sabinene, 3 and 4 carenes, zingiberine, α- and β-curcumenes and longifolene from natural sources and the synthesis of homoterpenylic, terpenylic and terebic, umbelluaric and non-carophyllenic acids deserve special mention.

He rendered valuable services during the initial stage of the foundation of the Indian Science Congress and acted as its secretary in 1917 and as its president in 1928. During the years 1910-1919 he was the professor of chemistry in the Presidency College, Madras. He was one of the chemical advisers of the Indian Munitions Board in 1919 and became Forest Chemist at Dehra Dun in the same year. He served as the Professor of Organic Chemistry in the Indian Institute of Science, Bangalore, during the period 1925-27.

His services as a chemist in India secured for him the Kaiser-i-Hind Medal in 1921, and subsequently the Fellowship of the Asiatic Society of Bengal.

He was appointed Professor of Chemistry at Bangor, North Waless soon after which he published the very useful book, *The Terpenes* in two volumes. The fellowship of the Royal Society came to him in 1932 as the crowning recognition of all his labours in the field of terpenes.

Sir C. V. Raman, Madras (1929)

Sir Chandrasekhar Venkata Raman, the only Nobel Laureate in Physics to the east of Suez, was born on the 7th November, 1888, near the town of Trichino poly. He had a uniformly brilliant academic career. He passed the Matriculation examination when he was barely twelve years of age. After two years of study at Vizagapatam he passed the First Arts examination obtaining a first class. He appeared at the B.A examination from the Presidency College, Madras, and was the only man to obtain first class honours in Physics. The two following years of post-graduate study constituted the most fruitful period of his collegiate life. Here he had the opportunity of plunging himself wholly into the study of Physics and naturally he was led to the study of acoustics. His first original contribution during these two years was on the asymmetrical diffraction bands due to an oblique slit. In the M.A. examination he obtained exceedingly high marks beating all past records. This was soon followed by his securing the highest place in the competitive examination for the Indian Finance Service.

Raman left Madras for Calcutta in June 1907 to join the Finance Department as an enrolled officer. He continued to serve this department for ten years till 1917, when he gave up the lucrative job for a professorship in Physics for which he was invited by Sir Asutosh Mookerjee. But even when under the yoke of service his unflagging zeal and indefatigable energy kept him busy in carrying out scientific investigations in the leasure hours. When in Calcutta this was greatly facilitated by the existence of the Indian Association for the Cultivation of Science, the laboratory of which was kept specially open for him. His work at that time dealt mostly with the study of vibrations and the theory of Indian musical instruments.

After accepting the Palit professorship of physics in the University College of Science, Raman took the cause of establishing for Calcutta University a reputation as a good centre of research in physics. His research activities soon extended beyond the bounds of the Palit Laboratory and he began to conduct the major portion of his investigations in the Indian Association for the Cultivation of Science, of which he became later the honorary secretary.

In 1921, he was nominated as a delegate of the University of Calcutta to the Congress of the Universities of the British Empire and he went abroad for the first time. He was invited to give a discourse on his optical and acoustical researches before the Physical Society of London. On his return to India he published an essay on 'the molecular

diffraction of light.' This was followed by a series of valuable theoretical and experimental researches on scattering, the crowning success of which was yet to come.

By this time honours had begun to pour on Raman. Early in 1922, the degree of D.Sc., *honouris Causa,* was conferred upon him by the Calcutta University. He was twice elected the president of the Physics and Mathematics Section of the Indian Science Congress. The next great recognition was his election to the fellowship of the Royal Society of London in 1924. He was invited by the British Association for the advancement of science to inaugurate a discussion on the scattering of light at its Toronto meeting. About the same time he was awarded a Ghosh travelling fellowship by the Calcutta University and he made an extensive tour through America, representing Calcutta University at the centenary of the Franklin Institute at Philadelphia. He was invited by Prof. Millikan to accept a visiting professorship of the California Institute of Technology. In 1925 he was again called out of India as a lecturer in the Mendeleff Congress.

In the following years, in collaboration with junior workers specially Krishnan he carried out a long series of investigations on optical anisotropy, magnetic anistropy, magnetic birefringence, etc. But his interest always centred round the problem of scattering of light which culminated in his monumental discovery, in 1928, of what he called 'a new radiation' produced in the process of scattering. This discovery has since been named in his honour as 'Raman Effect.'

Further honours were showered upon him. He was elected general president of the Indian Science Congress in 1929. During the same year he was knighted and was awarded the Matteucci gold medal by the Italian Society of Rome. In 1930 he was awarded the Hughes gold medal by the Royal Society of London. To the glory of the University of Calcutta that nurtured the genius of Sir C. V. Raman he achieved the highest scientific distinction by winning the Nobel prize in Physics for 1930.

Sir C. V. Raman continued as Palit Professor and head of the Physics Department of the University of Calcutta up to 1932, when the post of Director of the Science Institute at Bangalore was offered to him. Sir C. V .Raman is the first Indian Director of the Institute, of which he is now the head of the Physics Department. He presided over the Indian Science Congress in 1929.

Sir Richard Christophers, Allahabad (1930)

Sir Richard Christophers was born on the 27th November, 1873. He received his medical education at Liverpool University, where he took the degree of M.B., Ch.B. (Vict.) with first class honours in 1896. He also held the Holt Scholarship for Pathology.

During the period 1898-1902 he was a Member of the Royal Society and Colonial Office Commission on Malaria in Africa and India the results of which were communicated in a series of reports by himself and Professor J. W. W. Stephens.

Christophers entered the I.M.S. in September 1902. He was Superintendent of the King Institute of Preventive Medicine and Professor of Hygiene and Bacteriology, Medical College, Madras, in 1904. He was placed on special duty during 1907 and 1908 for an inquiry into Blackwater fever in the Dooars, and in 1909 was sent to investigate the causes of the great malaria epidemic which had visited the Punjab in 1908.

From 1910 to 1922 he was in charge of the Central Malaria Bureau, with a breach from 1915 to 1919 when he was on Military duty, chiefly in Mesopotamia.

From May 1924 to June 1925 he was Director of the Kala-Azar Commission and from June 1925 to his retirement from the service in 1932 he was Director of the Central Research Institute, Kasauli.

Since his retirement from the Indian Medical Service he has been engaged in important research work connected with malaria at the London School of Hygiene and Tropical Medicine.

Of his numerous scientific publications perhaps the most notable are the Reports to the Malaria Commission of the Royal Society mentioned above; contributions to the Scientific Memoirs by officers of the Medical and Sanitary Departments of the Government of India, which included an account of his work on *Leucocytozoon canis* and his report on Blackwater Fever in the Dooars, Malaria in the Punjab and Malaria in the Andamans; and the volume of Anopheline Mosquitoes in the Diptera section of the Fauna of British India. Christophers has been recipient of many honours, including the C.I.E. (1915), O.B.E. (1918) and the F. R. S. (1926). He was knighted in 1931. He presided over the Indian Science Congress held at Allahabad in 1930.

Lt.-Col. R. B. Seymour Sewell, Nagpur (1931)

Born at Leamington, Warwickshire, England, in 1880, Lt.-Col. R. B. Seymour Sewell was first educated

at Cleveland House School. At 14, having gained an entrance scholarship, he went to Weymouth College and in 1899 proceeded to Christ's College, Cambridge, where he held an Exhibition Scholarship for five years. In 1902 he gained first Class Honours in Part I of the Natural Sciences Tripos and in 1903 a 'Double First' in Anatomy and Physiology in Part II and was awarded the Darwin Research Prize. From 1903-1905 Sewell was a Junior Demonstrator in Anatomy and Physiology in the University Laboratories but in 1905 he entered St. Bartholomew's Hospital, having gained the Shuter Scholarship, and the following year was awarded the Matthew Duncan Prize; he qualified in 1907, taking his M.R.C.S.; L.R.C.P., and three months later passed into the Indian Medical Service. He came out to India in September, 1908, and at the conclusion of the necessary two years' Military Service was appointed Surgeon-Naturalist to the Marine Survey of India, joining the R.I.M.S. "Investigator" in September, 1910. At the close of the survey-season 1910-11 Sewell proceeded to Calcutta to the Indian Museum, to work up his collections and thus commenced a connection that was to continue to the end of his service. In December, 1911, he was appointed to officiate as Professor of Biology in the Medical College, Calcutta, and held the post till June, 1912, when he reverted to his appointment of Surgeon Naturalist. In 1913 he attended the International Congress of Zoology at Monaco and was appointed Vice-President of the Section of Oceanography. At the commencement of the War in 1914 Sewell was on leave in England, but he was at once recalled to India and was appointed Medical Officer to the 23rd Sikh Pioneers, then mobilizing for active service.

In May, 1918, Sewell was invalided back to India and on his recovery was sent up to Bikaneer to take Medical charge of the 1/141st Bikaneer Regiment, Shortly after the signing of the Armistice, Sewell was appointed to act as Superintendent of the Indian Museum during the absence on leave of Dr Stanley Kemp; and on Kemp's return to India in 1920 Sewell reverted to his original post of Surgeon-Naturalist and rejoined the Marine Survey, continuing to serve on the "Investigator" till 1925, when he was appointed Director of the Zoological Survey of India in succession to Dr N. Annandale, who had died the previous year. Sewell held this appointment for eight years. During this period he was President of the Zoological Section of the Indian Science Congress in 1927 and of the Anthropological Section in 1929, in which year he was granted the degree of Doctor of Science of Cambridge University; in 1930 he was elected President of the Royal Asiatic Society of Bengal and in 1931 was President of the Indian Science Congress at Nagpur and was appointed by the Viceroy to be Chairman of the Quinquennial Reviewing Committee of the Indian Institute of Science, Bangalore.

In 1932 Sewell was awarded the Berkeley Memorial Medal by the Royal Asiatic Society of Bengal. In 1933, Sewell was awarded the C.I.E., and was later appointed by the Secretary of State for India to be Editor of the *Fauna of British India* in succession to the late Lieut.-Col. J. Stephenson. The John Murray Expedition to the Indian Ocean sailed from Alexandria in His Egyptian Majesty's ship "Mabahiss" early in September, 1933, and was away for nine months. During this period Sewell was elected a Fellow of the Royal Society, London. On the return of the Expedition in 1934 Sewell settled in Cambridge, and was elected a Member of Council of the Marine Biological Association, Plymouth, and of the Linnean Society, London, becoming one of the Vice-Presidents of the latter Society in 1936. In the same year he had the honour of being elected a Corresponding Member of the Academy of Natural Sciences, Philadelphia, U.S.A.

Professor S. R. Kashyap, Bangalore (1932)

Professor Shiva Ram Kashyap was born at Jhellum on November 6, 1882, of a family which had a brilliant record of military services to its credit. After matriculating in 1899 from the Punjab University, he joined the Medical College at Agra. While a student there he passed the Intermediate Examination in Science of the Punjab University, in which he topped the list of successful candidates. Refusing a University Scholarship, he pursued his studies in medicine and obtained his Medical Diploma in 1904, standing first in order of merit. He then joined the United Provinces Medical Service. In 1906 while he was still in the Service he appeared at the B.Sc. Examination of the Punjab University and repeated his brilliant career by coming out at the top of the successful candidates once more. The same year he resigned his medical service and took up the post of an Assistant Professor of Biology at the Government College, Lahore. He took his M.Sc. degree in Botany in 1909, being first in the first class. He was awarded for his brilliant success the much-coveted Arnold and MacLagen Gold Medals of the University. In 1910

he went to Cambridge where he took two years later the honours degree in the Natural Science Tripos.

On his return to India, Kashyap was appointed Professor of Botany in the Government College, Lahore, in the senior grade of the Provincial Educational Service, and in 1920 was promoted to the Indian Educational Service. In 1919 he was appointed the University Professor in Botany, which post he held till his death in 1934.

Honours and distinctions came to him thick and fast. In recognition of his scholarship and services to the cause of science, the Government honoured him with the titles of Rai Saheb (in 1920) and Rai Bahadur (in 1929). In 1933, the University of Punjab conferred on him the honorary degree of D.Sc., he being the first recipient of the degree from the University. He was the first Secretary of the Indian Botanical Society, of which later on in 1925 he became the President. He was elected a Fellow of the National Institute of Sciences of India just before his death in 1934.

He was an original investigator in the field of Botany, and as such enjoyed an international reputation, the value of his researches being recognized both in India and abroad. He contributed many valuable papers on various groups of the vegetable kingdom, the most remarkable among them being those on the sexual generation of *Equisetum,* the Liverworts of the Western Himalayas, and the flora of Tibet.

Professor Kashyap was no doubt a pioneer in the realm of Botany, and can truly be said to be the father of the Indian School of Botany. He turned out quite a number of scholars in Botany, some of whom have achieved distinction in the field.

Professor Kashyap presided over the general body of the Indian Science Congress held at Bangalore in 1932.

On November 26, 1934, while working in his laboratory, he suddenly got ill and died in less than an hour, at the comparatively early age of 52. It can be said of the Professor that though he did not die full of years, he died full of honours (For a fuller account of his life and work, vide *Science and Culture,* Vol. I, pp. 38-42).

Sir Lewis Leigh Fermor, Patna (1933)

Sir Lewis L. Fermor was born in London on September 18, 1880, and entered the Royal College of Science with a National Scholarship in Physics and Chemistry, also obtaining the second place in the Honours list of the London Matriculation. Winning the Murchison Medal in Geology, he graduated A.R.S.M. in Metallurgy in 1901. In October 1902 he joined the Geological Survey of India as Assistant Superintendent. In 1906 he took the B.Sc. (London) by research and D.Sc., in 1909. He became the Director of the Geological Survey in 1932.

Sir Lewis is the author of numerous papers in Indian Geology—mainly on the manganese deposits of India and the rocks in which they occur, field-work which resulted in his monumental four-volume memoir on the "Manganese Ore Deposits of India." He collaborated with Sir Thomas Holland and Sir Henry Hayden in the Quinquennial Review of the mineral production of India for the periods 1904-1908 1909-1913 and contributed the articles on manganese in the succeeding Quenquennial Reviews for the periods 1914-1918, 1919-1923, and 1924-1928. As Director, Sir Lewis compiled the Annual Reviews of the Mineral Production of India for the years 1921, 1924, 1927, 1929, 1930, 1932 and 1933 and the General Reports of the Geological Survey of India for 1921, 1930, 1931, 1932, 1933, and 1934.

As representative of the Government of India Sir Lewis attended the International Geological Congresses in Sweden (1910), Canada (1913), Spain (1926), and South Africa (1929), and was editor for the volume on Asia of the International Lexicon of Stratigraphy prepared by the Congress.

In 1906 he was awarded the Government of India Prize and in 1917 the Silver Medal of the Institute, Sir Lewis has been Vice-President of the Asiatic Society of Bengal, its President and also the first President of the National Institute of Sciences of India. He was president in 1919 of the Section of Geology of the Indian Science Congress, and in 1932-33, President of the whole Congress. He is also a Founder-member of the Himalayan Club and was its Vice-President in 1931 and 1932.

Outside India Sir Lewis is a Fellow of the Geological Society of London, the Biology Medal of which was awarded to him in 1921, a member of the Mineralogical Society and of the Institute of Mining and Metallurgy, and a Fellow of the Royal Society.

Professor M. N. Saha, Bombay (1934)

Professor M. N. Saha was born on the 6th October, 1893, in a small village in the district of Dacca,

Bengal. He matriculated from a school in Dacca and passed the Intermediate Examination in science from the Dacca College, with great distinction in 1911. He then joined the Presidency College, Calcutta, and had among his teachers two of the most illustrious professors of the country, Sir J. C. Bose and Sir P. C. Ray, from whom he derived great inspiration. Although mathematics was his favourate subject in which he took his B.Sc. Honours (1913) and M.Sc. (1915) degrees, both with distinction, he was very intimate with these professors of Physics and Chemistry, and his close association with them brought to bear greatly on his future activities.

Soon afterwards Saha was appointed a lecturer in physics and applied mathematics in the newly founded post-graduate department of the Calcutta University, which had been just reorganized by Sir Asutosh Mukerjee. At this time, he turned to original research. The first contribution which he made independently, was on 'the limit of interference in a Fabry-Perot interferometer,' and in course of two or three years he gave good account of his innate capacity for original thinking. He was elected to the Premchand Roychand studentship in 1919 and in the same year was admitted to the D.Sc. degree for his highly meritorious thesis on 'A new law of electrical action.' Soon afterwards he took to the study of Astrophysics. His interest first centred round the long-standing problem of the spectra of the high level chromosphere of the sun. He showed from purely thermodynamical consideration that at the high temperature and low pressure in the high level solar chromosphere the atoms are mostly ionized, and this explains the prevalence of enhanced lines in their spectra. Thus he laid the foundation of his monumental work on the theory of thermal ionization, which was at first applied to the case of the solar chromosphere and was afterwards extended to the case of stars in general.

In recognition of this notable contribution Saha was awarded a travelling fellowship by the University of Calcutta, in 1920, which enabled him to come in contact with the eminent scientists of the West. The Griffith Memorial Prize was awarded to him in the same year. He proceeded to the Imperial College of Science, London, where he explained, from the view-point of his theory of thermal ionization of atoms, the exprimental evidences of various degrees of ionization in stellar atmospheres obtained by Prof. Fowler and others, and thus established his work on the theory of stellar spectra.

On his return to India in 1921, Saha was offered the Khaira Chair of Physics, which post he occupied for two successive years. Here he commenced experimental researches in order to verify his theory and also initiated research in other subjects in collaboration with junior workers. Greater facilities for his ever-expanding research activities came in his way when he joined the Allahabad University, in 1923, as head of the department of Physics, and opened there a new school of physical research.

New honours now began to pour in on Prof. Saha. He was elected to preside over the deliberations of the Physics and Mathematics Section of the Indian Science Congress in 1926, of which he became the general president in 1934. In 1927, he was elected to the signal honour of Fellowship of the Royal Society of London in recognition of his famous work on the theory of Stellar Spectra. He was invited to represent India at the International Conference of Physicists held in Italy in 1927, in connection with the Volta Centenary, where he gave an illuminating discourse on Complex Spectra. He accompanied the total Solar Eclipse Expedition to Norway, where many of the chromospheric lines predicted by him previously were discovered.

Saha's other contributions have been chiefly on selective radiation pressure, active nitrogen, spectroscopy and atomic and molecular structure, colours of inorganic salts, Dirac's theory of the electron, etc. Of late, he has interested himself in problems relating to the upper atmosphere and has thrown much light on the subject. In 1935, the Carnegie Trust of the British Empire elected him to an overseas fellowship. He went on tour through England and the Continent where he kept himself busy in intensive study and in important discussions with the eminent scientists on problems relating to the upper atmosphere. He attended the International Conference on Nuclear Physics at Copenhagen, and took active part in the discussions. Thence he proceeded to America to attend the Tercentenary Celebration of the Harvard University, and spent a long time in carrying on important investigation in the Harvard College Observatory.

Saha has been instrumental in bringing into existence several scientific societies in India, the most notable of which are the National Academy of Sciences (U.P.) of which he was the founder-president, the Indian Physical Society and the National Institute of Sciences of India of both of which he is the present president.

Saha's activities are not confined within the bounds of his laboratories alone. His extra-academic activities in the application of scienctific knowledge to the cause of national welfare are well known. In the columns of this journal, which is the organ of the Indian Science News Association, started mainly through his endeavours in 1935, and also else-where, he has repeatedly pointed out the pressing problems of national welfare, to which the attention and efforts of scientific specialists in India might well be directed. He has also frequently brought much pressure to bear upon the Government to take wise and bold steps and collaborate more freely with scientific specialists in India, for the amelioration of the wretched condition of his motherland.

Dr J. H. Hutton, Calcutta (1935)

J. H. Hutton was born in 1885 and educated at Chigwell School and Worcester College, Oxford, where he took his B.A. in 1909 and his D.Sc., in 1924. He entered the Indian Civil Service in 1909 and was posted to Eastern Bengal and Assam. From 1912 to 1918 he served in the Naga Hills as Assistant Commissioner, as Subdivisional Officer, Mokokchung, and as Deputy Commissioner. He was on special duty as Political Officer during the Kuku Operations of 1918-19, and in 1920 was awarded the C.I.E. for his services in that capacity. With short intervals of leave he served as Deputy Commissioner of the Naga Hills from 1920 to 1929, when he went to Delhi as Census Commissioner for India.

He was Honorary Director of Ethnography for Assam from 1920 to 1930, and Census Commissioner for India during 1929-33. Dr Hutton officiated as Chief Secretary for Assam in 1935, and on his retirement from the Service in the following year, he was appointed lecturer in the Department of Archaeology and Ethnology at Cambridge. In 1937 he was elected William Wyse Professor of Social Anthropology at Cambridge. Besides his *Report on the Census of India*, 1931, he has published two monographs in the Government of Assam's tribal series on the Angami and on the Sema Nagas. He has contributed introductions, notes etc., to several other volumes of that series, and has written grammars of the Sema and Chang Naga languages, not previously reduced to writing. He has also contributed a number of papers and articles to the *Encyclopaedia Britannica*, to *Man*, and to the Journals of the Royal Anthropological Institute, the Folklore Society and the Asiatic Society of Bengal. In 1929 he was elected a Fellow of the latter Society, having been a member since 1923. He has made occasional contributions to other periodicals, including *Antiquity* and the *Journal of the Royal Asiatic Society*. He presided over the anthropological section of the Indian Science Congress at Lahore in 1927 and over the whole Congress in 1935 held at Calcutta. He was awarded the Rivers Memorial Medal by the Royal Anthropological Institute in 1929, and the silver medal of the Royal Society of Arts in 1931. He was elected a Correspondent of the Anthropologische Gessellschaft of Vienna in 1931, and an Honorary Member of it in 1934, on account of his contributions to the study of anthropology.

Sir U. N. Brahmachari, Indore (1936)

Sir Upendranath Brahmachari was born on the 7th of June, 1875, in Jamalpur. He took his B.A., degree from the Hooghly College in 1893 where he was awarded the Thwyates Medal for standing first in Honours in Mathematics. He studied medicine and chemistry simultaneously and took his Master's degree in the latter subject in 1894 from the Presidency College, in the first class obtaining the University Silver Medal. He passed the M.B. Examination in 1898, standing first in Medicine and Surgery for which he was awarded the Goodeve and McLeod's Medals. He passed the M.D. Examination in 1902 and obtained the Ph.D. degree in Physiology in 1904. Sir Upendranath was a Coates Medalist and winner of the Griffith Memorial Prize of the Calcutta University, a Minto Medalist of the Calcutta School of Tropical Medicine, and Sir William Jones Medalist of the Asiatic Society of Bengal.

He was appointed teacher of Pathology and Materia Medica in the Dacca Medical School, and was subsequently appointed teacher of Medicine in the Campbell Medical School, Calcutta, which post he held for 20 years with great distinction and credit. It was here that he carried on most of his researches in Kala-azar and made his monumental discovery of *Urea Stibamine*.

Sir Upendranath has won for himself an international reputation as a research-worker. Since the beginning of his official career he carried on extensive researches in connexion with tropical diseases such as Kala-azar, Malaria, Blackwater fever, etc. He has also made contributions in Chemistry. His most outstanding work is, however, the discovery of *Urea Stibamine*, an organic antimonial which stands to-day

pre-eminent in the treatment of and campaign against Kala-azar and "has deprived the disease of its terrors". His *Treatise on Kala-azar* is the premier work on the subject. In 1926 he wrote the chapter on Kala-azar in Dr Carl Mense's *Handbuch der Tropen-krankheiten.*

Sir Upendranath has been the recipient of numerous honours. He has been the Vice-President of the Asiatic Society of Bengal, Indian Association for the Cultivation of Science, National Institute of Sciences of India and President of the Indian Chemical Society, of the Indian Committee, International Society of Micro-biology, and of the general body of the Indian Science Congress in 1936. He is a Fellow of the Royal Society of Medicine.

Rao Bahadur T. S. Venkatraman, Hyderabad (1937)

Born on the 30th June 1884, Venkataraman was educated in St. Joseph's College, Trichinopoly, and Presidency College, Madras. After graduating in Madras University, he joined the service of Madras Agricultural Department in 1907, as Assistant to Government Economic Botanist. On the establishment of the Imperial Cane Breeding Station in 1912 he came over with Dr Barber as his Botany Assistant. He was promoted to Class II Service, in 1918, and was appointed Officiating Sugarcane Expert in the following year on Dr Barber proceeding on leave preparatory to retirement. Promoted to I.A.S. in 1921, he was confirmed therein three years later. He has thus been in continuous charge of the Sugarcane Station for over 18 years. He was created a Rao Sahib in January 1920, a Rao Bahadur in January 1928 and a C.I.E. in January 1937.

He was deputed to Java in 1929 to attend the Convention of International Society of Sugarcane Technologists. He was again deputed in 1936 to attend the Fifth Congress of the International Society of Sugarcane Technologists in Australia and was permitted to revisit Java during the return journey.

Rao Bahadur Venkataraman presided over the Agricultural Section of the Indian Science Congress in 1928 and was elected General President of the Indian Science Congress in the year 1937. He is again to preside over the Agricultural Section of the Jubilee Session of the Congress. He is a Foundation Member of the National Institute of Sciences in India and a Fellow of the Indian Academy of Sciences, Bangalore.

He is Regional Vice-Chairman of the International Society of Sugarcane Technologists and Honorary Member of the South African Sugar Techonologists' Association.

Rao Bahadur Venkataraman is associated from the beginning with the scientific studies on the development of sugarcane crop in India. Jointly with Dr C. A. Barber, he played a prominent part in the successful raising of seedling canes in India, the basis and foundation of all the subsequent success in sugarcane breeding. Besides producing several varieties of canes suited to the different tracts in India, his work on root studies forms an entirely separate chapter in the knowledge of sugarcane root. The intergeneric hybridization between the sugarcane and sorghum achieved in 1930 and since successfully attempted in many stations of the world, was considered at the International Sugarcane Conference at Porto Navo in 1932 as the outstanding achievement of the Congress. In all crop breeding work the extension of the range and hence increase in number of characters available for working into the new hybride is the real foundation of all work. In both the sugarcane and sorghum hybridization and the most recent hybridization between the sugarcane and the bamboo, great advances have been made in the above direction to ultimately work entirely new characters into the future sugarcane types.

He presided over the Indian Science Congress in 1937 at Hyderabad (Deccan).

Research Institutes

[In the last issue we published brief accounts of the Government Scientific departments, and learned Societies in India. In the following pages we give similar accounts of the those research institutes, the adequate information of whose foundation and activities was available. We have omitted from this the various Indian Universities which are now active centres of research in different branches of knowledge. —Editor, Sc. & Cul.]

Imp. Council of Agricultural Research

The Imperial Council of Agricultural Research was established in June 1929 on the recommendation of the Royal Commission on Agriculture which reported in 1928. In chapter III of their report the Commission stated that the most important problem with which they had been confronted was that of devising some method of infusing a different spirit on the whole organization of agricultural research in India and of bringing about the realization on the part of research workers in this country that they are working to an end which cannot be reached unless they regard themselves as partners in a comon enterprise.

The objects of the Council as laid down in its Memorandum of Association are among others:

(a) To aid, develop and coordinate agricultural and veterinary research in India by promoting scientific (including technical) research, instruction and experiments in the science methods and practice of agriculture (including the marketing of agricultural produce) and by promoting veterinary research and instruction in veterinary science by the diffusion of useful information and by such other means as appear calculated to develop agricultural and veterinary research.

(b) To act as a clearing house of information not only in regard to research but also in regard to agricultural and veterinary matters generally.

(c) To establish and maintain a research and reference library in pursuance of the objects of the society with reading and writing rooms and to furnish the same with books, reviews, magazines, newspapers and other publications.

More briefly the Council affords a means for mutual co-operation in research for the improvement of agriculture for the whole of India in which every type of institution can take part.

The central organization is divided into two parts, a Governing Body which is responsible for the management of all the affairs and funds of the Council, and an Advisory Board, the functions of which are to examine all proposals in connection with the scientific objects of the Council which are submitted to the Governing Body, to report on their feasibility and to advise on any other questions referred to it by the Governing Body.

Besides the Imperial Institute of Agricultural Research at Delhi, the Council has under it three substations, *viz.*, the Imperial Institute of Viterinary Research at Muktesar, the Institution of Animal Nutrition at Izatnagar, and the Imperial Institute of Sugar Technology at Cawnpore.

Sir Bryce C. Burt is the present Vice-chairman and Mr. N. C. Mehta the Secretary, for a review of the work done during 1936-37 by the Council, the reader is requested to consult the November 1937 issue of *Science & Culture* pp 249-51.

Apart from the initial lump sum grant of 25 lakhs the Government of India have been giving an annual recurring grant of 5 lakhs for research work. They have also given a special grant of about 11 lakhs for urgent schemes of economic importance and about rupees 22½ lakhs for the encouragement of sugar-cane cultivation in India. They are also giving rupees 2 lakhs per annum, for a period of 5 years, for provincial marketing schemes.

The Imperial Council of Agricultural Research issues the following journals and periodicals regularly:

(1) *Agriculture and Livestock in India.* (2) *The Indian Journal of Agricultural Science.* (3) *The Indian Journal of Veterinary Science and Animal Husbandry.* (4) *Agriculture and Animal Husbandry in India.* (5) *Annual Report of the Imperial Council of Agricultural Research.* (6) *Scientific Monographs and Miscellaneous bulletins.*

The Imperial Veterinary Research Institute

The Imperial Bacteriological Laboratory, as this Institute was first called, was opened in 1890 in the

college of sciences at Poona by the Government of India for the systematic study of the contagious diseases of animals, such as rinderpest, anthrax Surra, etc. It was removed to Mukteswar in 1892, as the climate of Poona was not suitable for the finer operations of biological research. In 1899 the laboratory was completely destroyed by a fire in which many valuable records of the previous nine years were totally lost. It was rebuilt in 1902. In 1904 a short course of instruction in Tropical Veterinary Science and Serum Therapy was commenced for officers of the Army and Civil Veterinary Departments. Thus the Laboratory early in its career fulfilled the functions of an institution for post-graduate training in addition to its research activities. In 1925 the name of the Laboratory was changed to its present title.

There are 5 service and 3 Research Sections, as well as a separate Section for Production and Sales. The head of each section is directly responsible to the Director who organizes and directs the work of the Institute here and at Izatnagar, both on the research and administrative sides. The Service Sections are *(i)* Administration, *(ii)* Veterinary, *(iii)* Estate *(iv)* Engineering, and *(v)* Medical. The Research Sections are those of *(i)* Pathology, *(ii)* Serology, and *(iii)* Protozoology. Active research is carried on in these sections, chiefly in connexion with the domesticated animals as found in India, particularly with a view to providing efficient methods of prevention. The Institute conducts annually, between April and June, a short refresher course which is open to all gazetted officers of the Army and Civil Veterinary Departments and other veterinary graduates who possess a working knowledge of biology and pathology. Lectures are delivered in bio-chemistry, pathology, bacteriology, immunology, protozoology, helminthology and entomology, and practical instruction is given in the different laboratories and sheds attached to the Institute. In addition, post-graduate students may be admitted by the director on short practical courses, not exceeding 3 months, at any time of the year.

It has a branch Institute, called Imperial Veterinary Research Institute, at Izatnagar. It is intended to relieve the parent laboratory at Mukteswâr of as much as possible of the routine work of serum manufacture. The laboratory was first started at Kurgaina as a small station for carrying on certain experiments during the winter months, but the possibilities of serum manufacture in the plains were seen later, and it was expanded and developed. The Animal Nutrition S ction was started at Izatnagar in 1936 with a view to study the nutrition in relation to the maintenance of health, normal growth and productive capacity of animals in India. A Poultry Research Section is also to be opened shortly.

School of Tropical Medicine

The Calcutta School of Tropical Medicine owes its existence to the arduous labours of Sir Leonard Rogers, I. M. S., who in 1910 proposed its inception as a suitable memorial to the late King Edward VII, and commenced to raise funds for the scheme. The earlier proposals were for a small institution with three professors, attached to the Calcutta Medical College,—the "minor scheme". Later as the Endowment Fund grew, the present scheme—the "major scheme" was adopted and finally sanctioned by the Secretary of State for India in 1920.

The attached Carmichael Hospital for Tropical Diseases was built, equipped and endowed by public subscription at a capital cost of 3¼ lakhs. The School commenced work in 1921, but its official opening ceremony was not held until the 4th February 1922, when the School was officially opened by Lord Ronaldshay, then Governor of Bengal.

The annual income of the School is obtained from the Government of Bengal, the Indian Research Fund Association, and the Endowment Fund of the School. The School has always received the most generous support of the great industries, especially of the Indian Tea, Jute Mills, and Mining Associations. Lately a liberal grant has been given by the Imperial Council of Agricultural Research.

The School exists for the dual purposes of post-graduate teaching in tropical medicine and research work in tropical diseases. Three classes are held annually; one from October to April, terminating in the examination for the D. T. M. (Bengal); one from July to October, terminating in the examination for the L. T. M. (Bengal); and one in conjunction with the new all-India Institute of Hygiene lasting nine months for the D. P. H. (Calcutta). The classes are extremely popular, and all classes of medical men from sub-assistant surgeons, private practitioners, medical missionaries, assistant surgeons, both military and civilian, to I.M.S. officers have been trained. Students have come year by year from all over India, and from

many countries overseas such as Ceylon, Burma, America, China, Siam, Australia, New Guinea, Egypt and Kenya.

In the field of medical research the school has now an established international reputation. In Kala-azar the work here has been outstanding, and in epidemiology of Malaria a good deal of valuable work has been accomplished. Investigations in other tropical diseases, such as dysentery, spruc, and hill diarrhœa, intestinal helminths, filariasis, and leprosy, etc. have been carried out with admirable results. Col. Chopra, the Director of the Institute, has been busy for some time with work in connexion with the indigenous drugs, drug addiction (of which he carried out an all-India enquiry), and drug adulteration and spurious drug trade in India. A Biochemical Standardization Laboratory has recently been established to analyse and assay the purity and potency of medicinal preparations in the Indian market. It is hoped that this step will go a long way in checking drug adulteration and spurious drug trade in this country. A large amount of work has also been done in connexion with the etiology and treatment of epidemic dropsy and also some common but perplexing skin diseases of India.

The Pasteur Institute of Bengal was opened at the School in 1924. The growth of this department has been amazing. Owing to the extreme congestion this section has now been moved out to Ballygunge, decentralization has been introduced and the vaccine is now issued to centres throughout the province.

Bt. Col. R. N. Chopra, C.I.E., K.H.P., I.M.S., Sc.D., is the present director of the Institute.

The Forest Research Institute

The history of forest research and education in forestry in India has been intimately connected with Dehra Dun for the last fifty years, as the first college for training Indians in forestry was started there in the year 1878. But it was in 1906 that the Imperial Forest Research Institute was established.

The Inspector-General of Forests Sir Sainthill Eardley Wilmot was the first President of the Institute. There were six Research posts:—

(1) Imperial Silviculturist; (2) Imperial Superintendent of Forest Working Plans;(3) Imperial Forest Zoologist; (4) Imperial Forest Botanist; (5) Imperial Forest Economist; and (6) Imperial Forest Chemist.

The Industrial Commission pointed out in 1918 the necessity for expanding the Institute, and emphasized the necessity for increasing the number of Research Officers. The Board of Forestry in 1919, supported the proposals of expansion and the present site, which is about 4 miles away from Dehra Dun, was purchased. In this estate of 1,400 acres, are situated the main building for the offices of the President, Silviculturist, Botanist, Economist and Entomologist, the small buildings for the Chemical branch, the insectary, the saw mill, the pulp and paper plant, wood workshops, timber testing, timber seasoning and timber preservation laboratories, botanical garden, arboretum, experimental gardens and residential quarters for the staff. The main building was opened by His Excellency the Viceroy, Lord Irwin in 1929. The Institute is fully equipped with laboratories, museums and libraries for research work and it has cost Rs. 1,07,21,412 up to the end of 31st March, 1932.

The original main divisions of the Research Institute, excluding Working Plans, have been maintained; but these have been subdivided into sections manned by experts under the general control of the head of each branch. The work is now divided as follows:—

The President and Inspector General of Forests to the Government of India, is in charge of the Institute.

SILVICULTURAL BRANCH

This though not the largest, is the senior branch. It aims not only at speeding up, improving and cheapening production, but in the first instance at maintaining a supply of valuable timber from certain areas. The scope in the Branch is so large and the conditions of forests in the country are so varied that the Silviculturist has now to confine himself to the standardization of methods of research, to the organization of investigations, to the computation and record of data collected by local forest officers, and to assistance in applying information available in India or elsewhere in the world.

In order to gain firsthand knowledge from the local forest officers and to discuss and remove their difficulties, Silvicultural conferences are being held regualrly after every four or five years.

The distribution of types of vegetation (ecology) has been recognized to have considerable importance, and a beginning has been made in the study of damage

by fungi (mycology) to living trees and to felled timber. The herbarium of this Branch which contains considerably over 200,000 sheets has been used as the principal source of material for several Forest Floras.

ENTOMOLOGICAL BRANCH.

This branch is concerned with the investigation of damage by insects both in the forest and forest produce.

The most recent activity of this branch, the first of its kind in India, is the introduction of the biological control of defoliators of teak in South India by importing parasites of caterpillars that defoliate teak in Burma. These parasites, it is expected, will assist materially in checking the ravages of the pests and reduce the losses, which in bad years, have been estimated to exceed Rs. 100 per acre of teak plantation.

THE UTILIZATION BRANCH

This branch comprises separate sections dealing with wood technology, timber seasoning, timber testing, timber preservation, pulp and paper-making, wood workshop including veneer subsections and minor forest products. All these sections except the last one are under separate Sectional Officers who have received special training for their work.

TIMBER SEASONING SECTION

In this section the proper methods of seasoning are investigated as seasoning is an essential preliminary to efficient utilization of timber.

PRESERVATION TREATMENT

The Forest Research Institute has for many years been investigating the problem of making wood dur able, and is in a position to offer considerable help and advice on all matters connected with the treatment of Indian woods and timber preservation generally.

CHEMICAL BRANCH

This branch deals with problems involving chemical investigations and analysis. Its main function is research in connection with establishing and developing the use of many items of forest produce.

The study of forest soils is also carried on in association with the Silviculturist. It is hoped to develop the study of forest soils considerably in the near future.

MUSEUMS

There are five museums in the Institute namely, botanical, silvicultural, entomological, the timber museum and the minor forest product museum and according to " The Museums of India " by Markham and Hargreaves they may be described as among the best museum buildings in India.

PUBLICATIONS

Some 300 publications and number of educational and other works have been published by the Institute embodying the results of investigations carried out here.

The Indian Lac Research Institute.

India holds a virtual monopoly in the production of lac. The raw product stick-lac is cleaned and manufactured into shellac in a large number of small factories in Mirzapur, Balarampur, Jhalda, Murhu, Calcutta, and several other places in North India. About 97 per cent of the shellac manufactured in India is exported to foreign countries for use in the manufacture of gramophone records, varnishes, electrical insulating materials, sealing wax, hats, grinding wheels, etc., etc., less than 3 per cent being consumed in India.

Due to the extremely high fluctuations in price from Rs. 30 per maund in 1914 to Rs. 240 per maund in 1918, foreign consumers were taking to the use of synthetic products which were available at more uniform prices. The shellac industry was thus threatened with extinction like the indigo trade, and the Government of India, therefore, deputed Mr (now Sir) H. A. F. Lindsay, I.C.S., and Mr C. M. Harlow, I.F.S., to report on the industry. The Report was published in 1921. Their recommendation was that researches on the cultivation and manufacture of lac were necessary (*vide* Report on Lac and Shellac by H. A. F. Lindsay and C. M. Harlow). By the Indian Lac Cess Act of 1921 a small cess was levied on all exports of lac from India and the amount thus collected forms the research fund for lac. The income varies according to the quantity of exports, from one to three lakhs of rupes every year.

The administration of the fund was vested in a Committee of the principal shellac merchants of Calcutta from 1922 to 1931 and since then the Indian Lac Cess Committee appointed by the Government of India, in the Department of the Imperial Council of

Agricultural Research under Health, Land and Education portfolio, is controlling the policy of research and expenditure of the funds. The Vice-Chairman of the Imperial Council of Agricultural Research is the President of the Indian Lac Cess Committee, which is composed of an Advisory Board of experts and a Governing Body nominated and elected. The total strength of the Committee is 24. The Indian Lac Research Institute situated at Namkum (five miles from Ranchi) on about 120 acres of land including 90 acres for plantation, was started in 1925, under the directorship of Mrs D. Norris, with Biochemical and Entomological departments, the latter being in charge of Rai Bahadur C. S. Misra whose services were lent by the Pusa Agricultural Research Institute. The present Director, Dr H. K. Sen, M.A., D.I.C., D.Sc. (Lond.), F.N.I., joined the Institute in May 1936 and Mr P. M. Glover, B.Sc. (Leeds), joined as the Entomologist in 1929. There were four research assistants in 1925 but now there are eleven. The investigations have extended in scope from purely biochemical to organic, analytical, physico chemical and applied chemical researches. The Institute, in addition to its programme of research work, undertakes to train villagers in better methods of lac cultivation by means of several qualified demonstrators trained at the Institute for this purpose. The Institute is well equipped, having up-to date chemical and entomological laboratories, air-conditioned room, experimental lac factory, workshop, a plantation with the principal host trees, etc.

The Institute has published nearly 30 bulletins, 20 research notes, several leaflets and a few hand books on the cultivation, manufacture and utilization of lac and on entomological and chemical researches.

Since 1933, the Indian Lac Cess Committee has extended its research activity by opening an organization in England (The London Shellac Research Bureau) and another in America (The New York Shellac Research Bureau). There is a Special Officer, Lac Inquiry, in London as a liasion officer between research and trade. The London Bureau is wholly supported by the Indian Lac Cess Committee and the New York Bureau is in receipt of an annual grant. The object of the foreign research centres is to cooperate with the research departments of the consuming industries and to find new developments for the application of shellac in industries.

Haffkine Institute

This Laboratory is the principal Medical Research Laboratory of the Bombay Presidency and has been in existence for 40 years. Originally started by the Government of India under the Directorship of Dr Waldemar Mordecae Wolf Haffkine it has grown from a small institute to one of large dimensions. The present building was occupied in 1899. It was the then abandoned residence of the Governors of Bombay who had annexed the building from Jesuits in 1719. The Jesuits originally, in 1673, built a monastery at the site of a Hindu temple of Parali Vaijnath after which the village Parel was named. In this building the Institute was called Plague Research Laboratory; 1906, Bombay Bacteriological Laboratory, and finally, 20 years later (1926) Haffkine Institute. Several new departments have been added and now it is one of the largest institutes in India. Being a Government Institute it is financed by the Government of Bombay Presidency.

For 40 years this Institute has been the home of research on Plague. It has been, and still is, the largest producer of Plague Vaccine in the world (1-2 million doses per year). More recent work has shown that the vaccine manufactured here possesses great protective power. More recently researches of profound importance have been carried out which throw light on various problems in connection with Plague epidemiology, morphology and cultural characters of B. pestis, its maintenance,method of standardization of vaccine, and, finally, plague serum for therapeutic purposes. Laboratory tests and preliminary trials on human cases have given very promising results with our serum so far. Large quantities of other prophylactic vaccines are manufactured, *e.g.*, T.A.B., Meningococcal and Cholera Vaccines. Nearly 7 lakhs of doses of Cholera Vaccine alone are issued every year.

The Institute has the following departments:

(1) *Biochemical Department*: A very well equipped department which not only carries out large number of routine biochemical examinations for hospitals and other institutions but conducts research on serum concentration, normal physiological constants of adult Indians and vitamin assay work.

(2) *Pharmacological Department*: At present with the help of Indian Research Fund Association it is carrying out research on Plasmoquin, Atebrin and

acetyl-choline. Interesting observations have been recorded.

(3) *Diagnostic Department*: conducts routine bacteriological and pathological inevstigations for hospitals in the Presidency employing most recent methods and modern apparatus. More than 3,000 Wassermann tests are done yearly, in addition to cultural examination of blood, faeces, urine, etc. The Department of Pathology conducts research on pathology of Plague in experimental animals in addition to routine sections of pathological tissues.

(4) *Antirabic Department*: The Institute is the chief Antirabic Centre for the Presidency. In addition to manufacture of Antirabic Vaccine for distribution to "Out-centres" it treats a large number of out-patients from the City of Bombay.

Rat Examination for the Bombay Municipality is carried out. 2-3000 rats are examined daily for detection of plague epizootic. Important work is done on Snake Venom: A large number of snakes are kept. Venom is collected and dried and issued for experimental purposes and for production of Antivenin.

Facilities are afforded to private individuals for conducting research. A large library with 150 current monthly and weekly journals afford suitable assistance to workers. An annual report is published every year.

Central Research Institute

With the object of facilitating research into disease a scheme was initiated over thirty years ago by Colonel Leslie, Sanitary Commissioner with the Government of India, for the establishment of a Bacteriological Department for India. The Viceroy, Lord Curzon, and the Commander-in-Chief in India, Lord Kitchner, both lent their support and encouragement to this proposal. An essential part of the scheme was the establishment of a Central Laboratory and the Central Research Institute was accordingly opened in 1906 at Kasauli in the Simla Hills, some 6,000 feet above sea-level. Lt.-Colonel Semple, R.A.M.C. (Retd.), afterwards Sir David Semple, who was already well-known for his work on rabies and other bacteriological subjects was selected as the first director. The original building presented by the Kaur Sahib of Patiala was replaced on the same site in 1933 by a fine structure on modern lines with ample laboratory accommodation as well as adequate facilities for the housing of animals and for the various manufacturing processes.

In the years before the Great War this Institute was the headquarters of special researches in India on the typhoid fevers, on dysentery, and on malaria and it developed the manufacture of typhoid vaccine and also afforded courses of instruction in laboratory methods to selected medical officers.

During the Great War the activities of the Institute were devoted almost entirely to the manufacture of typhoid and cholera vaccines and later on of influenza vaccine. These had to be produced on an unprecedented scale for the use of troops in Egypt, Mesopotamia and East Africa, as well as in India.

To meet these demands, particularly with the difficulty of obtaining certain laboratory supplies under war conditions, meant a very heavy strain on the laboratory staff and much ingenuity was displayed by the officers concerned in devising methods to deal with the situation.

After 1920 it was possible to resume research activities at the Institute. The Malarial Section carried out important basic researches on many aspects of malaria and it assumed such importance that it has now become a separate organization, the Malaria Survey of India, under an independent director. The Entomological Section which was responsible for valuable research work, especially on the typhus group of fevers, is at present attached to the Malaria Survey of India. Dysentery, cholera, relapsing fever and snake venoms as well as various aspects of immunology have from time to time been investigated at the Institute.

The Institute is in close touch with the activities of the Indian Research Fund Association which was constituted in 1911 with the object of prosecuting research into medical problems. Many workers paid by the Association have been afforded laboratory accommodation at the Institute and officers of the staff have carried out or assisted in researches under the Indian Research Fund Association either in the Institute or in the field. In this respect the Institute has been important as a centre from which field enquiries have been carried out. Important basic work especially on immunological problems has also been accomplished. As a bureau of information the Institute has to deal with a large variety of enquiries on scientific subjects from the laity as well as from medical and other scientific persons. Information

and advice are freely given in response to such requests.

The director of the Institute is *ex-officio* editor of the quarterly publication of the Indian Research Fund Association, the ***Indian Journal of Medical Research,*** and also the ***Indian Medical Research Memoirs.***

The fine library of books on bacteriological and allied subjects is at the disposal of medical men and others who may either visit the library and work there or may obtain books on loan by post. The comprehensive store of scientific apparatus may also be made available for research workers, particularly those under the Indian Research Fund Association. No set course of instruction is carried out at the Institute but approved persons may be given instructions on special technique connected with problems which they propose to study.

In addition to research work the Institute has continued since the War the manufacture of vaccines for the military department entailing the issue of about two million doses of T.A.B. and other vaccines annually. A stock of imported sera for the military department is also maintained. The most important vaccine for the civil department is cholera vaccine and with the facilities developed during the war the Institute can deal with demands for many lakhs of doses. Another important product is Antivenene, a bivalent concentrated serum effective against the venoms of the cobra and Russell's viper, of which about 7,000 ampoules are prepared and issued each year.

Serological and other tests are also carried out for various hospitals and private practitioners and diagnostic sera and bacterial suspensions and other products are prepared to meet demands.

The Central Research Institute is administered by the Director-General, Indian Medical Service for the Department of Education, Health & Lands of the Central Government of India. The director is the senior member of the Medical Research Department (as the Bacteriological Department is now called) and the permanent staff includes three officers of the same department.

The first director was succeeded by Harvey and then by Christophers, both well-known in the medical research world, and the present director is Colonel John Taylor, C.I.E., D.S.O., V.H.S., I.M.S., who was one of the members of the Plague Research Commission.

The Indian Association for the Cultivation of Science

The Indian Association for the Cultivation of Science, one of the earliest institutions of its kind in India, was founded in 1870 when the only non official scientific institution of any importance was the Asiatic Society of Bengal. The foundation and the successful development of the Association was entirely due to the initiative and devoted work of Dr Mahendra Lal Sircar, a leading physician of Calcutta at that time. In 1882 the foundation stone of the lecture hall was laid by the Marquess of *Ripon, the then* Governor General of India, who also became the first patron of the Association.

The Association originally arranged for systematic courses of lectures and practical classes in various branches of science, *e.g.*, physics, chemistry, botany and zoology. It also arranged for the delivery of special lectures on scientific subjects. These activities of the Association met a great demand at that time as they supplemented the available resources. Now, however, the activities of the Association are being concentrated mainly on research, primarily in physics. Lectures on scientific subjects are also held, and some of these are open to the public.

The most important scientific event in the history of the Association was the discovery of Raman-Effect by Sir C. V. Raman in its laboratory. The Indian Association for the Cultivation of Science can justly be proud of the fact that the facilities it provided brought him the Nobel Prize for Physics.

The research work in the Association is now conducted by Dr K. S. Krishnan, Mahendralal Sarkar Professor of Physics, with a band of young workers.

The Association publishes the Indian Journal of Physics with which is incorporated the *Proceedings* of the Indian Association for the Cultivation of Science.

The latest annual report of the Association gives the total number of members to be 133 of whom 124 are life-members. It is located at 210, Bowbazar Street, Calcutta.

Scientific Departments and Societies

The Malaria Survey of India

Although various workers in India took a prominent part in the conduct of researches on malaria during the early years of this century, it was not until 1909 that a Central Malaria Bureau was set up at Kasauli. During the years which intervened between this date and the outbreak of the Great War, malaria work received a tremendous impetus, and largely owing to the researches of Sir Rickard Christophers India came to be regarded as one of the leading countries in the world in this subject.

These activities were interrupted during the War, but after the cessation of hostilities on the North-West Frontier in 1921 interest in malaria work began to revive. Interrupted researches were resumed and a number of special enquiries were instituted under the auspices of the Indian Research Fund Association. It came to be realized that in view of the enormous importance of malaria as a cause of mortality, morbidity and economic loss, it was essential to create an organization on a permanent basis, which would provide a team of skilled workers to undertake systematic research into the various aspects of the disease from year to year. With this object the organization now known as the Malaria Survey of India was inaugurated by the Indian Research Association in 1927, and it has been financed by that association up to the present date.

Its primary functions are to advise Government on all issues relative to malaria in India, to assist provincial organizations to carry out malaria investigations where desired, to conduct systematic research into the malaria problem in all its aspects, to advise and assist in the prosecution of antimalaria measures, to carry out epidemiological investigations, to teach and train officers and others in practical antimalaria work, and to act as a bureau from which information on all aspects of malaria can be obtained.

Under the energetic and able directorship of Lieut.-Colonel J. A. Sinton, V.C., I.M.S., the Malaria Survey of India quickly established a notable reputation as a research and advisory organization, and it has been increasingly used by health workers and malariologists throughout India and Burma. Special investigations have been carried out in certain centres in India where malaria is a serious problem. These include Bombay, Calcutta, Delhi, the Andaman Islands, Sind, Quetta, etc. The very diverse activities of the Malaria Sirvey are indicated by the numerous publications which have emanated from it, and which have appeared chiefly in the *Records* of the Malaria Survey of India. This is a journal devoted to malaria which was first published in 1929 and which is edited by the Director of the Survey.

A number of Bulletins dealing with malaria have also been issued by the Survey. These are continually being brought up to date by the issue of new editions.

A Malaria Course for Medical Officers is held each year at the Field Experimental Station of the Survey. Many workers who have undergone this course are doing valuable antimalaria work in various parts of the country.

The maximum sanctioned establishment of officers of the Malaria Survey of India under the Indian Research Fund at any period since its inauguration has been Director, Assistant Director, Entomologist, two Malaria Research Officers, a Malaria Engineer, and a Biochemist, but at no period have all these posts been filled at the same time.

The Government of India has recently announced its intention of taking over the Malaria Survey of India as regards its public health and advisory side, and this decision will take effect from April 1938. The research activities of the organization will be financed as before by the Indian Research Fund Association.

The Indian Central Cotton Committee

The need for a central body capable of giving to the cultivators, the merchants, the manufacturers and the central and provincial Governments expert advice as to the best measures which should be adopted for improvement in cultivation, marketing and manufacture of cotton having been greatly felt, it was with a view to serving these objects by co-ordination and concerted action that, in the year 1921, the Indian Central Cotton Committee was formed.

The aims of the Committee, as laid down in its constitution are (1) to advise the central and provincial Governments on all questions on cotton referred to it and to suggest suitable measures for the improvement and development of the industry, (2) to finance and to direct research work on problems connected with the improvement of Indian cotton including such investigations as the relationship between the cotton plant and its environments, the diseases and pests of cotton and critical examination of the lint qualities of the existing as well as the newly evolved types, and (3) to finance schemes intended to bring into general agricultural practice the results of economic importance obtained from research.

The constitution of the Committee is unique inasmuch as it comprises representatives of all sections of the cotton industry growers, gin and press-, owners, traders, exporters, spinners and Agricultural Department. Its meetings provide a common platform for exchange of views of all interests concerned before decisions affecting the industry as a whole are arrived at.

In the sphere of cotton research, the Committee has undertaken to finance a large number of schemes in several provinces and states. These schemes cover a wide range of research problems: (1) isolation of superior types of cotton, (2) investigation into the causes of shedding of flowers, buds and bolls and (3) the study of the life history of certain pests and diseases and the methods of combating them and (4) finding ways of overcoming the loss by wilt and root-rot.

The Committtee has also taken steps to train its own staff of technical experts and scientific workers by the award of research scholarships and training grants, tenable both in India and abroad.

With a view to disseminating the results of research and other activities of the Committee amongst the cultivators and other interests concerned, the Committee, in 1932, undertook a scheme of Publicity and Propaganda. Under this scheme regional campaigns are undertaken and practical demonstrations are given by means of the latest devices in the field of publicity and propaganda in order to bring home to the cultivator the results of important schemes financed by the Committee. By the issue of a regular stream of publicity literature, pamphlets, leaflets and coloured posters, a live and continuous contact is maintained with all cotton interests both in India and abroad.

The Committee's Technological Laboratory, which was opened in 1924, renders valuable assistance to the cotton industry of India. Equipped with most up-to-date instruments for testing the length of staple, waste losses and the strength and fineness of fibre, the Technological Laboratory issues results of the various tests which are of inestimable value to the cotton breeder and the trade. Exhaustive tests have been carried out on the variation in wastes of different trade descriptions of raw cotton stored for a year in Bombay godowns, and moisture tests have been made from samples drawn from trade bales. In addition, the Laboratory assists the trade by undertaking spinning tests on commercial types selected by the East India Cotton Association and Millowners' Associations of Bombay and Ahmedabad. Many other investigations of a technical nature connected with the manufacture of yarn from cotton, such as, the application of various systems of high-drafts for spinning Indian cottons and the influence of different atmospheric humidities on the spinning performance of cotton, are also undertaken at the Laboratory.

Indian Medical Association

The Indian Medical Association is an organization that was established in 1929 for the advancement of medical and allied sciences, the improvement of Public Health and Medical Education and the furtherance and protection of the medical profession in India. It has several branches and a number of affiliated bodies all over India. Its membership is open to all medical practitioners registered in India. The general management of the Association is vested in a Central Council which in addition to the President and three Joint Secretaries and others consist of representatives from the branches elected on the basis of membership. The Association conducts a monthly journal which is provided to all members. Once a year there is held under the auspices of its Association an All India Medical Conference at which scientific and medico-political questions affecting the profession in the country are discussed. Conferences in the provinces are also organized from time to time by the branches.

This Association came into being as a direct result of the Fletcher Committee's report on Medical Research in India which brought to a focus many

of the disabilities under which independent medical practitioners in India labour. A further incentive to the formation of this organization was given by the controversy over the withdrawal recognition of medical degrees of Indian universities by the British General Medical Council. In this controversy and the formulation of the Indian Medical Council Act arising out of the controversy the I.M.A. played a large part generally leading Indian medical opinion in the country. Since its formation the I.M.A. has increased rapidly in membership and the number of branches has also increased and its influence appears to be growing. Dr G. V. Deshmukh was elected its first President and among other eminent persons who have served as President are Sir Nilratan Sircar, Dr B. C. Roy, Major M. G. Naidu, Dr Jivraj Metha, late Dr M. A. Ansari, late Col. Bhola Nauth and Dr Rama Rau. Dr B. N. Vyas is the President for 1936-37. Dr Rochiram A. Amesur (Karachi), Dr Bhupal Singh (Meerut) and Dr Kumud Sankar Ray (Calcutta) are the Honorary Secretaries for the year. The Head Office of the Association is located at No. 67, Dharamtala Street, Calcutta.

The Indian Botanical Society

The Society had its inception in a resolution passed by the Botany Section of the Indian Science Congress at the Nagpur meeting in January 1920, and it was finally established towards the close of that year. The Society is administered by an executive council consisting of a President, two Vice-presidents, a Secretary, a treasurer who is also the Business Manager of the Society, and ten Councillors. The President, Vice-Presidents and Councillor serve for one year each, the Secretary and the treasurer for three years each. The Society publishes the *Journal of the Indian Botanical Society* which is issued bimonthly. The present President of the Society is Dr S. R. Bose, Dr E. K. Janaki Ammal is the Secretary.

SUPPLEMENT—Abstracts of the Sectional Presidential Addresses to the Jubilee Session of the Science Congress.

Physics and Mathematics

The Sources of Energy of Storms

C. W. B. Normand.

The collection of data of the upper air, for which we in India pay tribute to the late Mr. J. H. Field, has introduced a gradual revolution in the study and practice of meteorology in India, as it has done over the rest of the world. The forecaster's methods have altered much. Whereas 25 years ago scanty data regarding cloud furnished almost the only indications of the ongoings within the ocean of air, to-day the forecaster has small auxiliary charts of streamlines for the levels of ½, 1, 2 km. and for a few higher levels up to 6 km. if low clouds do not intervene. The empirical stage was inevitable and has not yet ended; but the forecaster of to-day finds weather forecasting to be much more interesting exercise than it used to be. Contrast the man who was content simply to forecast "rain" with one who tries to picture the process, and distinguish between the different types, of rain-formation. The forecaster of to-day always has the physical problem before him.

The general theme of the following paragraphs concerns the thermodynamical approach to the study of storms. At the basis of it all, following Margules, there is a simple enough proposition, namely:- if the whole air mass around and including a storm can be circumscribed and considered as a closed system, it should be possible from a study of the initial and final conditions alone to decide the main source of the kinetic energy that has been created and displayed during the storm's existence. After discussing certain assumptions, the address goes on to point out that before either the gravitational or the internal energies can decrease within a closed system the stored-up energy must be present in a state of instability, actual or potential. The possible diversities of instability, though numerous, are believed to be composites of three main kinds, which are called for brevity the vertical, horizontal and latent types. The vertical and horizontal types refer to the behaviour of dry air, or at least air which is dry enough to remain unsaturated during the changes considered. The latent instability is that which arises from the latent heat of water vapour.

Liquids in a jar or strata in the ocean set themselves according to density, but the layers in the atmosphere always tend to take up positions according to their entropies those of greatest entropy uppermost. The best picture of the normal atmosphere is that stressed by Sir Napier Shaw of stratified layers, each of lower entropy than that above it, and each resilient and to a certain degree obstinate and resistant to any attempt towards upward or downward motion of other masses of air through it. The sun's heat on the ground is a potent agent in creating vertical instability, which however is not of prime importance in the study of storm's energy, because, behind it, there is no means of storing up energy.

The second, *i.e.*, horizontal type of instability is exemplified by a warm and a cold current of air moving parallel to each other. We are all accustomed nowadays to the notion of the meeting of air masses from different parts of the earth, of polar air encountering tropical air, or monsoon air coming into proximity with continental air. Here, on account of the earth's rotation, there is a means of storing up energy, because so long as the surface of discontinuity is in equilibrim a large difference of temperature may be maintained between adjacent air masses. When the position of equilibrium is broken down by any agency, perhaps by a pronounced pressure wave, there is obviously a considerable store of potential energy readily available for transformation into the kinetic form of wind and gale, the cold air breaking through with all the display of a "line squall" or "cold front."

The third main type of instability arises from the latent heat of water vapour and is dependent upon the power of vapour in the atmosphere to act as a reservoir of energy. Just as there is a limit to the lapse-rate of temperature for dry air, so there is a limit to the lapse rate of wet bulb temperature, which on being exceeded is a potential source of energy. The (venti-

lated) wet-bulb temperature is, in fact, an interesting physical entity, worthy of a little more attention than it ordinarily receives in text-books of physics. See, for example, its importance to the engineer, faced with problems of air-conditioning.

Refsdal in Norway was the first to explain clearly certain essential conditions for the storage of energy by water vapour. Almost simultaneously a slightly different approach was made in India to this problem. A kind of metastable conditions was recognised and defined as "latent instability." This is an interesting type of instability because it can develop behind a veneer of stability. It is of the same type as a vertically expanding pencil standing on end, or analogous to a hydrogen balloon caught in the corridor of a large hall where it can be fed with more hydrogen, but cannot escape up to the dome untill given a small push. So also a quantum of air in the atmosphere that is in the state of "latent" instability due to water vapour will respond to large but not to small displacements.

These are the main types of instability and we wish to have a means of estimating quantitatively their relative importance in originating storms. Recently graphical methods have been borrowed to clarify and extend the work of Margules, who originated the standard method of attack on such problems. The temperature-entrophy diagram (or tephigram) is chosen, with mass as a third coordinate. The energy that is released during the change from initial to final conditions arises from the fall of the centre of gravity of the system and from an associated decrease in the internal energy. What does that energy amount to?

Solutions can be given for cases of vertical instability of both discontinuous and continuous type. In the former case the total energy is given approximately by the volume of a wedge, and in the latter by the volume of a pyramid built upon the "tephigram" base. Horizontal instability is shown to be the half-way house between vertical instability and complete stability; hence the discontinuous and continuous types of horizontal instability also have their energies represented by the volumes of a wedge and pyramid respectively, but of only half of the height of those for vertical instability.

To gauge the possible importance of latent instability a brief study is made of a somewhat extreme example to estimate how much kinetic energy can, at the maximum, be produced by latent instability alone, unassociated with other types of instability. If we imagine the descending air to be unaffected by the falling rain, the maximum energy that may be generated within the closed system is represented by the volume of a fairly simple solid figure of which a model has been prepared. This energy, when averaged over the whole mass, is found to be equivalent to a hurricane of 80 miles an hour. Great though this velocity is, it does not express all the theoretical possibilities of "latent instability." If the sylphs of the air were interested enough to take charge of each descending unit and to see that it derived full advantage from the falling rain, they would increase the available energy. In fact by building up another model on the tephigram and comparing its volume with that for the ascending air, we see that the descending air, if kept saturated by judicious descent along with raindrops can contribute as much to the available energy as the ascending air. That is, the over-turn of the air in the closed system can give rise to a hurricane averaging 115 miles an hour throughout the air column, if the process is conducted with maximum thermodynamic efficiency.

A more practical case may perhaps be illustrated using Poona and Agra data. The available energy from this combination, which may represent the two air masses over the Bay of Bengal in pre-monsoon storms, suffices to provide an average velocity of 50 miles an hour distributed throughout the whole system, if evaporation from rain is not taken into account, and over 60 miles an hour, if it is.

The relationship of these ideas to storms of the type of thunderstorms, duststorms and cyclones is briefly discussed. The conventional text-book diagram of the processes occurring in a "heat" thunderstorm is obivously inefficient and probably insufficient, because it stresses only the upward movement of air from near the surface of the ground and pays no attention to the streamlines of the upper air. The ideal, efficient, self-propagating thunderstorm, in which rain-drenched descending winds play their part, ought to resemble more the flow of streams of water of varying temperature debouching from a multichannelled circuit, the hottest stream from the lowest channel and the coolest on top.

Regarding tropical cyclones, we recall Henry Piddington who invented the word "cyclone" here in Calcutta some 90 years ago. The forecasters, who

deal with the cyclones of the Bay of Bengal, have built up impressions from day-to-day experience. They associated most major cyclones with the presence of two more distinct air masses over the Bay; and they recognise also the great importance of water vapour in them. The first of these at first sight suggests horizontal and the second latent instability as the source of energy. It is doubtful however whether sufficient latent instability can develop in any homogenous air mass. There is reason to expect that the seat of most intense latent instability is in the partition zone between the two main air masses and that this must be the main source of energy which, though often released in the form of rain and thunder squalls, is sometimes and somehow organised into cyclonic form. More field work is required however to settle even the primary thermodynamical questions about the relative importance of the different types of instability. The required upper air data must include good observations of humidity as well as of temperature. The Bay of Bengal, with its tropical cyclones, is ever a challenge for further work.

Chemistry

A Survey of Recent Advances in Magnetism Relating to Chemistry

—S. S. Bhatnagar

The subject of magnetism in relation to chemistry has attracted special interest only during recent years although Faraday, Perkin, Curie, Honda and Owen showed early how it could be usefully employed in solving chemical problems. These developments had to wait, as the theoretical side of magnetism was rather shrouded in mystery. The theoretical advances in magnetism following the lead of Langevin and the great strides in atomic physics and quantum mechanical theories have facilitated the application of this subject to chemistry. Special mention must be made of the contributions of Van Vleck, Stoner, Bloch, Heisenberg, Lewis and Pauling.

The rapidity with which the subject of magnetism in relation to chemistry has grown may be judged from the fact that after the appearance of the first book in English on the subject of magnetochemistry by Bhatnagar and Mathur (Macmillans, 1935), two books—one by Honda, and the other by Klemm- have already appeared, and even in the short period which has elapsed since the appearance of these books, there has been an almost encyclopaedical output of work on magneto-chemical problems.

In the domain of nuclear chemistry, magnetic measurements have helped in assigning a constitution to the nucleus and in confirming the Heisenberg theory of neutron-proton constitution of the nucleus. From the observed and calculated nuclear magnetic moments, the important conclusion drawn is that it is not possible for an electron to exist inside the nucleus. As a result of this conclusion, a hypothetical particle with no charge and with a mass equal to or less than that of the electron has been postulated. A theory of the hyperfine structure has been proposed on the assumption that the magnetic moment of the nucleus combines with the magnetic field produced by the electrons and with the orbital moment. The discrepancies in the earlier work on magnetic moments for iron, nickel and cobalt atoms have cleared up by the more recent work of Klabunde and Phipps. In the University Laboratories at Lahore we have been able to show SO_2 vapour is paramagnetic and therefore has a $^3\Sigma$ ground state like O_2 and S_2. This interesting observation settles the dispute in which spectroscopic evidence was not decisive. Also the molecular states of iodine have been determined at Lahore and it seems certain from magnetic data that iodine ionises in carbon disulphide and benzene, but remains in the molecular state in cyclo-haxane. Recent measurements on the magnetic properties of elements particularly of the rare earths have helped in clearing up the electronic constitution of these difficult elements. Amongst other elements which have attracted special attention are chromium, bismuth, barium, rehenium and mercury.

The work on bismuth is of special interest because of its unusual magnetic behaviour and the investigations of Goetz and collaborators and of de Haas and van Alphen have therefore attracted much atten-

tion. The magnetic susceptibility of mercury was given a value of—0.19×10^{-6} by Honda. Recent work at Lahore for mercury from various sources assigns to it a value of—0.172×10^{-6} which is in excellent agreement with the value obtained by Bates and Tai. The mercury vapour has a very different susceptibility, namely 0.39×10^{-6}. The disagreement between the values for the vapour and the liquid is probably due to mercury polyatomic molecules.

Much interest in the measurements of susceptibilities along different axis in a crystal has been exhibited by the work of Krishnan and Miss Lonsdale and it has been established that these determinations besides the X-ray method yield valuable information regarding the crystal structure. The magnetic work at Lahore on active carbon which is used in gas masks and for decolorisation, has revealed the fact that the process of activation consists in the development on the surface of carbon of graphitic crystals differentially oxidised. From a series of carefully planned experiments involving a rigorous control of the method of preparation of elements, their powdering and chemical examination, it has been shown at Lahore that there is no effect of the particle size on magnetic susceptibility in the case of bismuth, antimony, sulphur, selenium, tellurium, lead, copper and tin upto 0.4μ. Where chemical changes are excluded, the observed changes in magnetic susceptibility have been shown to be due to the change in microcrystalline structure. This view has been supported by Prins, Lessheim, Lane and others. Perhaps the most important subject in magnetism from the point of view of the chemist is that of molecular diamagnetism. As a result of extensive systematic investigations of the magnetic properties of non-polar organic compounds, Pascal discovered the principle that molecular susceptibility is equal to the sum of atomic susceptibilities of all the atoms in the molecules and a corrective constitutive factor depending upon the nature of linkage between the atoms.

Recent measurements have confirmed and extended Pascal's work. Amongst outstanding contributions may be mentioned the determination of the corrective constitution factors for addition compounds at Lahore.

As regards paramagnetism, ions, molecules, free radicals and bi-radicals exhibiting this phenomenon have been abundantly investigated and in general the conclusions arrived are that this is due to the orbital angular momentum of an incomplete electron shell or to its resultant spin.

The theoretical work of Bose, Stoner and Van Vleck has particularly helped in the understanding of this interesting property.

The magnetic susceptibility values have been ingeniously employed to decide controversies regarding structure. Of great interest is the application of this method to the elucidation of the structure of the constituents of blood. The metal complexes of porphyrin dervatives, the basis of blood, were found by Klemm to be diamagnetic and were regarded by him as true complexes. Similar results have been obtained by Pauling on the magnetic properties of the constituents of hemoglobin. As a matter of fact these measurements have contributed much to the assignment of a proper constitution to hemoglobin, carbonmonoxyhemoglobin and other constituents of blood.

Magnetic measurements have also cleared the problem of the existence of a single electron bond. Lowry, for example, assumed the existence of single electron linkage in compounds of the type dimethyl tollurium iodide, but the magnetic researches at Lahore showed that this substance is diamagnetic in a fair range of temperature. This is in accord with wave-mechanical theory, which rejects the possibility of a single electron bond in all cases except that of the hydrogen molecule ion.

Amongst other applications of this subject I may mention the investigations of Bhatnagar and Farquharson on polymerisation and the researches on magnetic properties in relation to phase equilibrium. Certain rules regarding structure, formation of intermediate compounds, etc. have been formulated. For example, it is concluded that in the case of solid solutions, the susceptibility-concentration curve is a curved line, in the case of a mechanical mixture of the constituents, the curve is a straight line, whilst the appearance of a new phase indicating the formation of a compound brings about an abrupt change in the slope of the curve. These generalizations have been used by numerous investigators in the study of alloys.

It has been found that the magnetic field influences the rate of chemical change and adsorption and these investigations have opened up a new line of

work on the kinetics of reactions and the mechanism of the chemical change. Information on the nature of phototrophy can be obtained from magnetic measurements. Phototrophy in several cases results from the change of aggregation of matter under the influence of light, although in some cases such as the transformation of anthracene into dianthracene, a more intricate intramolecular change is involved.

I have said enough to lay bare some of the fascinating features of this subject.

In concluding this survey, I cannot help hoping that this historic meeting will help us in forging new bonds of personal magnetism which will lead to further advances in Physics and Chemistry and to the cementing of the relation between the East and the West and the old and the new worlds.

Geology

Structure of the Himalaya and of the North Indian Foreland

—D. N. Wadia

Geological work carried out during the last few years has thrown much light on the structure of Northern India, a region of the extraordinary geotectonic interest, as much on account of the magnitude and intensity of the crustal deformations, involving the upwarp of the Himalayan chain and the formations, at its foot of the deep parallel Indo Gangetic depressions, as on account of the extreme youth of those world transforming events. The region of Northern India resolves itself tectonically into two broad belts, the plicated geosyncline of the Himalayas and the edge of the Indian peninsular massif, that has acted as the foreland and in the process sagged under the strain of the folding of the northern orogen. The structure of this foreland is revealed in four principal units: (1) The Rajputana plateau, prolonged northwards into the "Punjab wedge" of Gondwanaland, which has played such an important part in moulding the trend of N. W. Himalaya; its main tectonic strike is transverse to the Himalayan strike. (2) The Potwar trough, a tertiary geosyncline containing 25,000 ft. of fluviatile deposits. (3) To the south east the Potwar geosyncline widens into the great synclinorium of the Gangetic trough, 1200 miles long and 200 miles wide, mostly filled up by late Pleistocene alluviation. (4) The Assam plateau, a tongue of the Gondwana mainland, has played the same part as the Punjab wedge in moulding the Himalayan trend at its eastern extremity. The Assam valley is a "ramp" valley.

But few parts of the Himalayas have been so far investigated in detail for their structural plan. Areas in which detailed mapping and stratigraphic and tectonic work have been carried out are the Kashmir mountains, the Simla area, a part of Garhwal and the neighbourhood of Mt. Everest in Sikkim. In Kashmir the Himalayan system of earth folds undergoes a deep syntaxial bend round a pivotal point a narrow promontory of the Punjab foreland hidden under the late Tertiary deposits. The most important tectonic feature of this N. W. Himalaya re entrant are two concurrent thrust planes delimiting the autochthonous fold-belt at the south foot of the Himalayas against the edge of the foreland, which have traced round the syntaxis for a distance of 250 miles. The inner of these thrusts marks the front of the Kashmir *nappe* of pre-Cambrain and older Palaeozoic rocks, which has moved southwards along a low plane of thrust and encroached upon the autochthonous belt of Carboniferous Eocene succession, obliterating it at places. Four overthrusts have been noted in the Simla mountains, representing flat, recumbent folds of great amplitude. The Pre Cambrian here is piled up on the Carboniferous and Permian sequence. The Simla rocks are totally unfossiliferous and the evidence of the superposition of highly matamorphosed pre Cambrian, building some of the prominent peaks near Simla (*Klippen*) over the less altered younger rocks, is obtained by a study of relative metamorphism, unconformities, thrusts, etc. In the Garhwal area recent mapping has proved two superposed *nappes*, the Krol and Garhwal *nappes*, composed of the older rock formations overriding the autochthonous Carboniferous Eocene sequence of the Outer Himalayas.

Evidence of the extreme youth of Himalayan orogeny has multiplied in recent years; investigations in

Pleistocene, glacial and fluviatile deposits of the Kashmir valley suggest that between 5000-8000 ft. of uplift has taken place since the end of the Pliocene. A part of the address deals with the recently discovered gravity anomalies, both positive and negative, in the Himalayan region, which cannot be explained on the hypothesis of isostasy. On the whole, compensation is in excess in the central Himalayan ranges, while the outer Himalaya is an area of overload under-compensation.

The arcuate form of the Himalayas, presenting to the south three prominent festoons, is best explained as the result of three crustal pegs arresting the free movement of the plastic folds pressing against the Indian horst under pressures from the north. The Great Himalayan range, built mostly of granite or pre-Cambrian sediments, from the Brahmaputra gorge to Nanga Parbat on the Indus, thus denotes the Himalayan protaxix, the axis of original upwarp of the Tethyan geosyncline. At both its ends it has undergone sharp southward deflections to accommodate itself to the shape of the foreland.

Geography and Geodesy

The Physiography of Rajputana

—A. M. Heron

The Physiography of Rajputana was described by Dr. A. M. Heron in his address to the Geography and Geodesy section.

Rajputana, a congeries of Indian States, has an area of 130,462 square miles, and is roughly rhombus in shape, with sides of over 500 miles in length.

The main geological interest of Rajputana is its long succession of pre Cambrian rocks belonging to six separate systems or series, and, in one area, the presence of Archaeans in an extraordinarily unaltered condition.

The Aravalli mountains run across it in a north-east and south-west direction from Delhi to the plains of Gujrat. This is a very ancient range of folded rocks, deeply eroded, but still bearing summits of over 4,000 feet in height.

North-west of the Aravalli range is a sandy waste diversified by rugged hills of granite and ancient acid volcanic lavas, with exposures of jurassic and eocene strata far to the west. South-east of the range is a rocky gneissic plain, sloping gently eastward to the plains of Hindusthan, and in the extreme south-east is the plateau of horizontal Vindhyan sandstones, with the lava flows of the Deccan trap reaching its southern base. A great fault runs along the north-east margin of the Vindhyans and this Dr Heron suggests, may be mesozoic in age.

In plan, the folds which make up the range are like a pair of fans joined by their handles. The narrow handle portion is probably a simple syncline, but to the north-east and south-west of this construction, complicated folding comes in and each fan is a synclinorium of isoclines, dipping to the north-west.

Folding steepens as one passes across the synclinoria from south-east to north-west, concurrently with the increase in metamorphism and the amount of igneous intrusion.

A peneplane has been detected, levelling the tops of the high quartzite ridges, but raised towards the centre of the range, and falling along its length to either end. The author suggests that this peneplanation took place in the Mesozoic age and that the range was rejuvenated and this peneplane arched by movement contemporaneous with the formation of the great fault.

Lt.-Col. R. B. Seymour Sewell has suggested that the great submarine ridge on which are situated the coral atolls of the Laccadive, Maldive and Chagos archipelagoes, is a continuation of the Aravalli range.

It is believed that the steep, straight coast of western India is determined by a fault parallel with the coast, and later than the Deccan trap, the Rajputana fault being earlier than the trap.

If these assumptions are correct, the Aravalli range was peneplaned in the Mesozoic, re-elevated before the beginning of the Tertiary, and the southern, submarine continuation of it was let down in the Tertiary, after the Deccan trap was outpoured.

A second possible peneplane of Tertiary age is

represented by the erosion surface of the softer rocks, to the east of the range and in the valleys above which rise the great resistant quartzite ridges truncated by Mesozoic peneplane.

There is a third peneplane, of "sub recent" age, of the older alluvium of *bhangar* of the Indo-Gangetic plains. In this the present rivers are eroding their beds and depositing the newer alluvium or *Khadar*.

Zoology

Zoology and its Advancement in India

—Dr G Matthai

He said oceanographical investigation of the Indian Ocean was conducted since the first meeting of the Indian Science Congress mainly by R. I. M. S. ' Investigator ' (till 1926) and the John Murray Expedition (1933-34), under the direction of Lt. Col. Seymour Sewell, F.R.S. Previously the "Sea-lark" Expedition, under the leadership of Prof. J. Stanley Gardiner, F.R.S. had surveyed the Western Indian Ocean south of the Maldives, more particularly the islands of the Chagos Archipelago and the Hascarene region (during 1905-1906 and 1908-1909). The work of the Sea-lark expedition was mainly on problems relating to coral reefs and atolls and their Biology, and was a continuation of a previous study of the Maldives and Laccadives. The R. I. M. S. "Investigator" concentrated its work in the Andaman Sea and the Bay of Bengal. The recent work of the John Murray Expedition was in the region of the Arabian Sea, not covered by the Sea-Lark Expedition. The study of the Deep Sea Biology of this region was assisted by physical, chemical, hydrographic and topographic investigations. The Survey of India collaborated with the John Murray Expedition in the cruise down the Maldives for making pendulum observations with a view to determining the nature of the foundations on which the Maldives and Laccadives are situated.

The work of the R. I. M. S. "Investigator" has extended our knowledge in regard to variation in the air temperature over the open waters of the Indian seas, in the wind force in the amount of rainfall and in the relationship between the temperature of the sea surface and that of the air. There is always a vertical circulation of the layers of water caused largely by differences in temperature and salinity. A reversal of seasons is noticeable in the Indian seas at a depth of about 100 fathoms, comparable to the phenomenon that takes place in the temperate seas.

The "Murray Ridge" discovered by the John Murray Expedition appears to be ultimately connected with the Carlsberg Ridge. The latter ridge divides the western region of the Indian Ocean into north-eastern and south western halves "King Fand Bank" is probably a submerged stoll with a distinct rim about 40 feet high and level floor 130 fathoms deep.

Regarding the reefs of the Western Indian Ocean, Prof. J. Stanley Region differs from the Chagos Archipelago in regard to conditions of reef growth, changes adverse to reef growth taking place at a much faster rate than in the latter. The regression of the coral reefs in the Mascarene region does not appear to be due to any biological reason such as sedentary organism that cause destruction by boring into the reefs, since the activity of such organisms is decreased at the depths at which reefs of this region are situated, nor by sediment which cannot settle on the seaward sides of reefs and banks nor by precipitation of calcium carbonade (for such precipitation is not visible on coral polps on the seaward sides) nor by currents whose action is less on the sides facing sea, nor by temperature which at 50 fathoms is not lowered than 61 degree 9 F., nor by any decrease in the amount of plankton that serve as food material to coral polps, for it is not liable to much quantitative variation in the Indian Ocean, nor does the chemical composition of the surface water in the Indian Seas show any appreciable difference. The comparative poverty of the deep sea fauna in the Chagos and Mascarene regions is perhaps due to the hardness of the sea floor and to the fact that the quantity of plankton which serve as food material to the larger organisms is less in the Indian Seas than in the temperate regions. In

spite of the "shallow and fierce conditions" of life on the reefs of these regions it is interesting to observe that the animals do not exhibit any special structural features that may be regarded as adaptations to the peculiar enviromental conditions.

The Zoological Survey of India, has been engaged mainly in faunistic investigation, more specially of the brackish water of the Whilkalate and its island (Barkuda) the estuarine fauna of Goa, the fauna of the Mutlah river of the Inle lake, the Indian fresh water Molluscs and their Trematode parasite, the aquatic terrestrial fauna of the Punjab Salt Range, the cave fauna of the Siju cave in Assam. Particular attention has been paid to the study of the fishes of hill streams in various parts of India and their structural and other adaptations to this peculiar environment. Fisheries research, specially 'Trochus' was conducted in the Andamans.

Dr. Matthai made a brief survey of the zoological study in India and concluded his address thus: "The future of our science in India is secure in the hands of the enthusiastic zoologists working in different parts of the country. Its advancement will be still further enhanced by the establishment of a Department of Zoology at every seat of learning in India."

Entomology in India

Past, Present and Future

M. Afzal Husain

India claims to have domesticated the silkworms, she has cultivated the lac insect for thousands of years, and has used honey, as food, and in rituals since prehistoric times. Ancient Indians made elaborate studies on the medicinal values of insects and invented repellents to protect themselves from insect tormentors. An Indian Entomologist invented the name *Satpada*, hundreds of years before Latreille's (1825) term *Hexa poda*. Atharva Veda contains hymns on control of insect life.

Linnaeus (1758) included in his "Systema Naturae" 12 species of Indian insects, and thirty years later Fabricius (1792-98) included in his "*Entomologia systematica*" one thousand Indian species, collected mostly by the Christian Missionaries. Thus during the last 150 years insects have received much attention, members of the Asiatic Society of Bengal, the Bombay Natural History Society and workers in the Agricultural, Forest and Medical Departments had made contributions to insect study. It is estimated that so far 40,000 species of insects have been studied from India.

The number of the existing species of insects in India cannot be less than 2.5 millions. Therefore, we only know one insect of our country for every 60 that we know not. The condition of our insect collections is also very unsatisfactory. It is distressing to find that most of the 'types' Indian insects have gone out of the country. In our museums we have hardly one 'type' for every hundred species described.

The Indian Museum laid the foundation of Agricultural Entomology in 1884 and the Imperial Institute of Agricultural Research at Pusa and the Agricultural Department in the provinces and some Indian States have carried on the work. The Indian Central Cotton Committee, the Imperial Council of Agricultural Research, the Indian Tea Association and the Indian Lac Association have fostered the study of the insects of agricultural importance. Similarly the small band of workers in Forest Entomology have achieved much success.

Ronald Ross and the workers who followed him, have made most valuable contributions to Medical Entomology, which have been of utmost utility to humanity. The Indian Research Fund Association has financed much research on insects of medical importance.

Veterinary Entomology has been greatly ignored, and it is only lately that an Entomologist has been appointed to study insect pests of domesticated animals.

In education entomology has long been the Cindrella among sciences. Even in Agricultural

Colleges it is only within the last few years that entomological teaching has received some attention. In most Medical and Veterinary Colleges Entomology has no place in the curricula.

We are equally behind in Entomological literature. There is no literature on insects in any of the vernaculars of India. The Fauna of British India is not developing as fast as one would wish it to develop. We have few catalogues of insect groups.

According to Sir Thomas Holland among the sciences of economic value entomology perhaps ranks first in importance to India. Sir Mirza Ismail has drawn a very gloomy picture of the conditions in our motherland. Over one hundred million people suffer from malaria every year and one million succumb to its effects. "The debility, poverty and apathy caused by this disease are factors of magnitude in retarding the national, social and economic progress of the country." *Anopheles*, brought about the decay of the Greek and Roman civilizations, and is today one of the major obstacles in our progress. According to Fletcher the sugarcane pests alone cause an annual loss of 300,000,000 rupees. The hide industry of this country suffers a yearly loss of 1.5 crores of rupees from one insect--Ox Warble Fly. At a very modest computation the annual loss caused to India by insects has been put at 200 crores of rupees, and a loss of over million and a half of human lives. It is a truism that insects have been responsible for more destruction of property and loss of life than caused by all wars, floods, earthquakes, fires and famines in human history, and the losses caused by them are on the increase. Advancing civilization is producing conditions most suitable for insect multiplication and spread.

The tribute of Rs 200 crores which India pays to the demons *Satpada* is a heavy drain, which should not be permitted to continue. An effective defence against these enemies will reduce this enormous wastage and India will have enough money for her national development. To effect this we must produce an army of workers to study insect life in all its aspects and an army well equipped with knowledge and machinery to fight these demons. The public must be made to appreciate the importance of insect study. Entomology must take its place in our schools and universities, agricultural, medical and veterinary colleges. Funds should be provided to develop pure and applied Entomology. We have depended far too long on the generous assistance of foreign workers and institutions for the progress of Indian Entomology, but time has come when we must shoulder our burden. In every province and every State insect surveys should be conducted, Museums for insect collection and insect study established. Indian Universities should come forward to take their full share in entomological development.

Entomology has long ceased to be a subject of purely national interest. Insects recognise no political barriers. India has been invaded by insect pests of other countries and in return Indian insect pests have reached other lands. Quarantines have been established, certificates of freedom from disease are demanded for importation of plants. Warfare against insects shall have to be carried out on international basis in the near future. Our country, therefore, must be prepared to take its place among the ranks of the international force for war against insects.

We need an Entomological Society of India and an Entomological journal.

Anthropology

The Racial Composition of the Hindukush Tribes

-Dr B. S. Guha

Dr B. S. Guha addressed the Anthropological Section upon "The Racial Composition of the Hindukush Tribes."

The region south of the Hindukush and Karakorum mountains, occupied a strategic position in the racial geography of India, for in these difficult, high mountainous valleys were still sheltered some of the remnants of the northern steppe folks who invaded India in the second millennium B. C.

Linguistically the tribes living in this area

could be classified under two heads, namely, Dardic and Burushaski, with Kaffiri occupying an intermediate position between Iranian and Indian. Burushaski was unrelated to any known language, but Morgenstierne's investigations had shown the essentially Indian character of the Dardic and even the Kaffiri languages.

The earliest investigations on the somatic characters of these interesting tribes were those of Ujfalvy followed by Stein, Dainelli and the author himself, who, as a member of the scientific expedition sent by the Government of India, visited Kaffristan and Chitral in 1929.

From a careful consideration of physical characters, it appeared that the basic racial type in the entire region was a short, dark dolichocephalic strain with prominent long nose, often aquiline, which might be regarded as a variant of Eugen Fischer's *Oriental race* and the most characteristic type of the region.

Besides this principal type they had the southern extension of a broad headed race closely allied to what was known as the *Dinaric race* of eastern Europe. In its strongest form it was found among the Khos of the Chitral valley and the Burushos of Hunza Nagir, though it occurred throughout the Dardic tribes in varying degrees. The skin colour in this race was prevailingly of a rosy white tint but the eyes were more often hazel and green, and the colour of the hair was brown.

The third main racial strain was a tall dolichocephalic type with long and straight nose. It formed a very important layer among the Kaffir and the upper stratum of the Burusho and the Dardic tribes. The distribution of the cephalic index in this type followed the same trend as found by Ariens Kappers in the races of the Aral-Caspian regions and very similar to that which formed the dominant element in the North European population, from whom its chief distinction lay in the integumentary colours.

Whereas in Sweden the blond type represented 49% of the population, among the Kaffirs it did not exceed 15%. Blondness, as was well known, was due to a deficiency mutation which suppressed the appearance of pigment. It is certain that this deficiency mutation had occurred in this and at least in another, namely, the *East-Baltic race*, at some time or other. It was probable that the mutations for skin, eye and eye colours had taken place separately.

In the Baltic tribes the high rate of the deficiency mutation might probably account for the larger percentage of the blond as compared to the Hindukush tribes, among whom the activators were perhaps dominant over suppression causing the general persistence of the more pigmented people.

Lastly, an intruding Mongoloid element must also be responsible for the yellowish tint in the skin colour and broad flat nose found among many individuals.

The proportions of these strains varied in different parts. The Dinaric and the Proto-Nordic elements were stronger in the western valleys, whereas the basic Oriental and the Mongoloid elements were more conspicuous in the eastern valleys of the Upper Indus.

Agriculture

Hybridization— Its Scientific and Economic Aspects

—T. S. Venkatraman

The Presidential Address at the Agricultural Section dealt with the main aspects associated with the scientific work that has been responsible for the production of the now-world-famous Coimbatore sugarcanes. In the improvement of crops in India through breeding sugarcane stands first in results, the area under improved sugarcanes occupying over 70% of the total against 19% for wheat, 16% for cotton and 4% for paddy. The Address presented a record of a quarter century of intensive breeding work on this crop. The Coimbatore canes with the help of Tariff protection have materially altered the position of India in the matter of white sugar.

Though the Indian Sugar Industry dates from ancient times, the classes of canes grown over the bulk of the Indian area (Sub-tropical) were some of the

poorest in the world. In fact, research has shown that they belong to a totally different race from most other sugarcanes of the world which are tropical. While India was probably the home of the Indian race of canes which, though poor, are hardy, the island of New Guinea is believed to be the original home of the other race of thick canes.

The growth period for canes over the bulk of India is round about six months against the 12 to 18 or even 24 months in the other cane countries. Secondly, the Indian crop has to pass through very wide variations in climatic conditions during its growth period, a parallel to which is found only in countries like Natal or Lousiana. These somewhat difficult conditions necessitated a complicated hybridization programme involving the use of various types of sugarcanes including certain wild species. The success of the Coimbatore work is attributed to this complicated breeding programme. In the wealth of material, available in the country as parents, India surpasses most other countries and the Coimbatore station has been taking full advantage of this circumstance.

The mode of inheritance of characters in the cane is different from most other crops and the process of hybridization also presented various difficulties all of which have been successfully overcome. The various life processes by which new sugarcane types originate were described as also the different species of *Saccharum* found in the world.

Systematic Botanists have divided the grass family, to which sugarcane belongs, into Sub-families, Genera, and Species. One popularly accepted definition of Species is that they do not readily cross with one another. Crosses between Genera are rarer still and between Sub-families almost considered impossible. In the course of the economic work at Coimbatore it has been possible not only to cross sugarcanes with other species but other Genera like *Sorghum* (1930) and with a totally different Sub family of grasses, viz., the Bamboo (1936). These hybridizations are considered likely to have far reaching repercussions on the classification of the grass family as a whole. Their economic utility lies in the fact that these wide hybridizations might render possible the introduction of entirely new genetic characters into the future canes from Coimbatore.

Medical Research

The Conquest of Kala-Azar and Certain Observations on the Chemotherapy of Malaria

— **Sir U. N. Brahmachari**

The earliest epidemic of kala-azar in Bengal ('Burdwan fever') occurred in the seventies of the last century, when it was probably complicated with malaria. In this epidemic the fell disease had mocked every human effort, and absorbed in its powerful grasp, day by day and inch by inch, every blessed spot which once used to be prized for its salubrity. In more recent times the epidemic of the disease in Nowgong district of Assam produced such an appalling mortality that there was a decrease of 31.5 per cent. in population of the place in the decade 1891-1900.

The mortality from the disease has now been reduced from 90% or more to 1 or 2 per cent. Including complicated cases, it has been reduced from 99 to less than 10 per cent.

The conquest of kala-azar may be said to have begun when Cristina and Caronia obtained remarkable results in infantile kala-azar of the Mediterranean basin by the use of tartar emetic. It has been observed (Brahmachari and co-worker) that when metallic antimony is injected intravenously in an leishmania-infected experimental animal in a state of fine subdivision, the particles are picked up by the same cells in the spleen as those that harbour the parasites of kala-azar and that in the struggle that ensues the fight ends most remarkably in the complete destruction of the parasites in the speediest way. It is one of the most powerful leishmanocides.

It has been found that in the campaign against kala-azar, treatment with tartar emetic or sodium antimony tartrate had the disadvantage of being long and tedious. In Assam which was once the hot-bed of the disease, mass treatment with these drugs was

therefore found difficult to enforce, as patients discontinued treatment altogether or attended very irregularly after a few injections. It was felt that kala-azar in Assam is demonstrated from statistics from the Annual Public Health Reports of the Government of Assam quoted below:

STATISTICS OF NUMBER OF KALA-AZAR CASES TREATED BY THE GOVERNMENT OF ASSAM AND THE NUMBER OF DEATHS FROM THE DISEASE

PROVINCE OF ASSAM AS A WHOLE

Year	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935
No. of cases treated ..	60,940	49,385	33,415	23,576	23,804	16,430	12,592	11,958	12,650	13,398	11,100
No. of deaths ..	6,365	4,176	2,859	1,660	1,405	953	1,017	987	749	770	845

DISTRICTS

Sylhet

Year	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935
No. of cases treated ..	10,934	16,335	10,527	8,988	9,162	6,726	5,512	4,719	4,210	4,612	3,869
No. of deaths ..	2,109	1,320	798	482	429	274	246	296	146	227	260

Goalpara

Year	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935
No. of cases treated ..	6,003	5,671	3,495	2,316	2,389	1,439	992	1,089	1,159	1,107	1,245
No. of deaths ..	453	297	226	166	135	112	121	122	92	64	100

Kamrup

Year	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935
No. of cases treated ..	8,753	7,301	6,445	3,577	2,598	1,814	1,690	2,061	2,223	2,197	1,465
No. of deaths ..	1,120	714	475	241	180	102	160	152	129	151	176

Darrang

Year	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935
No. of cases treated ..	5,262	4,414	4,053	2,228	1,399	1,106	942	665	757	876	738
No. of deaths ..	478	474	318	258	241	185	222	155	167	136	91

Nowgong

Year	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935
No. of cases treated ..	13,895	9,586	5,008	2,614	2,433	1,440	1,057	1,075	1,663	1,726	1,651
No. of deaths ..	1,445	839	528	260	178	132	129	132	110	78	52

Garo Hills

Year	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935
No. of cases treated ..	1,952	2,812	1,828	1,690	2,905	1,905	882	605	850	927	690
No. of deaths ..	435	346	350	154	149	84	64	48	34	23	58

the difficulties in reducing the number of 'Stopped Treatment' cases would be overcome more effectively, if some drug could be introduced which would be more efficacious than tartar emetic and take a much shorter time to effect a cure. Such a drug was found in 'urea stibamine.' Its value in the campaign against

The figures for Cachar which are not exhibited in the above tables are very interesting. Out of 5,188 cases treated from 1925 to 1936, the number of deaths was 56 showing a percentage of less than 1.08 per cent. Out of 574 cases treated in 1936 the number of deaths was 2 showing a percentage of less than

0.3 per cent. The incidence of the disease in Assam has been reduced from 60,940 in 1925 to 10587 in 1936 and the mortality from 6365 to 753 during the same period. The disease has lost all its terrors in the Province and people who suffer from it are less afraid than those who suffer from malaria.

The Kala-azar Commission, India, used, throughout the seven years of their existence, urea stibamine only, in the routine treatment of kala-azar. According to them the acute fulminating type characteristic of the peak period of an epidemic responded to treatment with urea stibamine extraordinarily promptly and with an almost dramatic cessation of fever, diminution in size of the spleen and return to normal condition of health.

In 1933, the Director of Public Health, Assam, noted that " It is no exaggeration to say that approximately 3.25 lacs of valuable lives have been saved to the Province."

In 1922, in studying the treatment of kala-azar, the speaker observed certain remarkable skin erup

interest than kala-azar. The chemotherapy of quinoline and acridine compounds in malaria may one day play an important part in the campaign against the disease and its conquest. While some quinoline and acridine compounds have marked destructive action on paramoecia, most of them have been observed to have no action on the parasites of malaria when used clinically in patients suffering from the disease.

Recently a compound having a similar composition to that of quinacrine or atebrin has been synthesized in the speaker's laboratory. It has been used as hydrochloride or hydrobromide. Its action in benign tertian and malignant tertian infections in man is indentical with that of atebrin. Shortt and Menon have observed that in a series of experiments carried out with this compound and atebrin on monkeys infected with *Plasmodium knowlesi*, the effect of the two drugs in sterilizing the peripheral blood, the cure rate, and relapse rate were identical. Its effect on paramoecia is noted below:

	Experiment No. I	*Experiment No. II*	*Experiment No. III*
STRENGTH	EFFECT ON PARAMOECIA	EFFECT ON PARAMOECIA	EFFECT ON PARAMOECIA
1:1,000	Death in 2 to 4 minutes	Death in 3 minutes	Death in 2 to 5 minutes
1:5,000	Death in 4 to 6 minutes	Death in 3 to 5 minutes	Death in 4 to 6 minutes
1:10,000	Death in 8 to 10 minutes	Death in 7 to 10 minutes	Death in 6 to 9 minutes
1:40,000	Death in 12 to 15 minutes	Death in 10 to 14 minutes	Death in 10 to 15 minutes
1:80,000	Majority died in ¾ of an hour	Majority died in 1½ hours	Majority died in 62 minutes
1:100,000	Majority died in 1¼ of an hour	Majority died in 1½ of an hour	Majority died in 1½ hours (few survived)
1:120,000	Few deaths in 1½ of an hour	Few deaths in 2 hours	Few deaths in 2 hours
1:160,000	No death in 2 hours.	No death in 2½ hours.	No death in 2½ hours.

tions caused by *Leishmania donovani* developing in kala-azar patients two or three years after completion of antimonial treatment and apparent cure, though under ordinary conditions, in kala-azar the skin shows very little involvement or none (*Dermal Leishmanoid*). Viable leishmania have been cultured from these skin lesions in test tubes and sandflies. They are therefore a source of infection and the conquest of kala azar cannot be regarded complete unless these lesions are either averted or quickly cured. In the campaign against kala-azar and its conquest, proper handling of cases of dermal leishmanoid is an important point to be taken into consideration.

Certain Observations on the Chemotherapy of Malaria

Research in malaria-therapy has been intense in recent times. In certain parts of India it is of greater

The discoveries of effective antimalarials and leishmanocides rank among the highest triumphs of synthetic chemistry in its application to tropical medicine.

The author concludes by saying that if along with the conquest of malaria and kala-azar there is in India ' a proper balance between labour-saving devices and industry-increasing discoveries,' and if her people ' will but decide to put in play the methods,' which science today has provided for sufficient supply of food and clothing and shelter, then the health and economic problems of India, with her endless natural resources, will be solved to a great extent and much of her unrest and unemployment will cease and she will have the opportunity of being richer, happier, healthier and freer than ever before.

Veterinary Research

India's Veterinary Problems

—Sir A. Olver

Sir Arthur first paid a high tribute to Sir Fredrick Hobday's life-long devotion to the interests of the veterinary profession. He then gave an account of the development of veterinary work in India from 1788. The account was of absorbing interest and rapidly approached the time when the first veterinary school was opened in 1874 at Babugarh.

In 1881 the Government of India offered a prize worth Rs. 200 for the best original paper on the horse disease commonly known as Kumari or Paraplegia and in 1883, with a view to encouraging the study of veterinary science, the Governor of Bengal offered two prizes, one of £50 and the other of £20 open to Army holders of agricultural scholarships from Bengal, who had studied at the Royal Agricultural College, Cirencester.

Thus the value of veterinary work gradually became established but even to-day the position of disease control in India is peculiar in that there are no veterinary practitioners, except a few in Calcutta and other big cities, and stock-owners are almost entirely dependent on Government veterinary services for veterinary aid.

It is therefore incumbent upon Governments to organize and maintain suitable provincial veterinary services for the control of contagious disease and to provide veterinary aid and assistance in the proper care and management of live-stock.

In the early days, these services were mostly under the Director of Land Records and at that time there were no veterinary colleges in India.

The obvious step for the advancement of veterinary science was therefore to establish suitable colleges or schools for the training of veterinarians in India and when graduates became available, provincial veterinary services were gradually organized by officers transferred from the Army Veterinary Department to take charge of the newly formed Civil Veterinary Departments.

Veterinary hospitals and dispensaries were opened at suitable centres and the work of the Departments has gradually been developed and extended as more graduates have become available.

The scope for development of veterinary work in India is however immense, not only in the control and treatment of contagious and enzootic disease, which is rife, but also in such animal husbandry matters as systematic control of breeding operations, and inoculation of improved stock against diseases combined with organized castration, at a suitable age, of inferior males not required as sires.

Owing to the general lack of wealthy land-owners who take a genuine interest in livestock improvement this work is of the greatest importance and recently the Government of India has recommended that all animal husbandry work should be in the hands of Provincial and State Animal Husbandry Departments, based on the existing Provincial Veterinary Departments.

At present this work is partly in the hands of Veterinary Departments and partly Agricultural Departments but it is clearly essential that veterinary graduates from Indian colleges should in any case be thoroughly trained in the fundamentals of animal husbandry, particularly as there hardly exists in India an educated class of scientific stock breeders from which young men with hereditary knowledge and interest in live-stock could be drawn for the control of breeding operations.

Indians who have received veterinary training have already proved their superior value in such work and with a view to increasing existing facilities, particularly for training in animal husbandry, it has recently been recommended that a dairy should be maintained at every veterinary college in India and that the I.D.D. course should be open to veterinary graduates, after a reduced course of study in addition to what is given in their graduate course.

One of the most important steps ever taken for the development of veterinary work in India was the appointment in 1891 of an Imperial Bacteriologist, whose headquarters were in the first instance at Poona. After two years, it was decided to instal this officer at a Veterinary Research Laboratory at Muktesar, in the Kumaon Hills, 'for the investigation of diseases of domesticated animals in all provinces in India.

The first Imperial Bacteriologist was Lingard, a medical man, who among other things discovered the specific affinity of arsenic for the parasite of Surra: a discovery which has led to results of the greatest importance to the human race.

From the day of its establishment in the Kumaon Hills, where it was free to carry on systematic research in animal diseases of all kinds, the Muktesar Institute has built up a world reputation and has done an immense amount of work of the greatest value to Indian stock owners.

The most important advance from the point of view of owners of live-stock has undoubtedly been the great step forward which has been made in the control of rinderpest due to the general adoption of a system of vaccination with goat virus.

This method has been evolved as a result of the continuous research and investigation, which has been carried on at Muktesar for many years, into all matters relating to rinderpest control. In the course of this work Dr. J. T. Edwards produced a goat virus of fixed and reduced virulence for the ox and from this beginning a method of vaccination has been evolved there, which has proved highly successful and economical in controlling outbreaks of rinderpest among plains cattle, without the use of anti rinderpest serum.

This discovery has made it possible to control outbreaks at a fractional cost, compared with the cost of the serum simultaneous or serum alone methods, and at the same time to confer lasting immunity which, so far, has proved to be a solid one, for as long as it has been possible to test it, *i.e.*, up to more than 3 years.

For the poor cultivator of India whose very life depends on his cattle, this is an immense boon and the fact of cattle plague being so comparatively easily and cheaply controllable has enabled Provincial Veterinary Departments to devote more attention to other fatal diseases such as haemorrhagic septicaemia, and anthrax.

These still take a heavy toll of the cattle of India but are now better under control by means of biological products, evolved for the most part in other countries, and during the past 5 or 6 years great advance has been made in the treatment of Surra as a result of research at Muktesar and systematic investigation carried out in the Punjab and other provinces.

After indicating other directions of advance Sir Arthur said the field for scientific veterinary work in India is immense and that fully trained workers are few. Meanwhile the poor ryot has to suffer continuous and heavy loss from a great number of causes which, with more and better trained staff and more adequate provision for combined veterinary and animal husbandry activities, could easily be brought under better control.

The provision of a central veterinary college, to provide training up to the M.R.C.V.S. standard and in research, in conjunction with the Veterinary Research Institutes of Izatnagar and Muktesar, is being taken up by the Government of India but more fully qualified staff and better facilities for research and animal husbandry training are urgently needed at most of the existing colleges; to enable them to train up to modern standards and to carry out such diagnostic work and research as can suitably be undertaken at such colleges.

This has become all the more necessary since the provision by the Imperial Council of Agricultural Research of a Veterinary Investigating Staff, in each major province and certain States, which it is now proposed to extend and develop for the systematic investigation of disease problems all over the country which is so urgently needed. This investigation work has increased the demand for co ordinated veterinary research.

" The field for such work is unlimited and up to the present almost untouched but, for such work, high standards of education and veterinary training are needed and I appeal to Indian veterinary institutions of all kinds to aim constantly at producing veterinarians fully equipped for such work and able to take the predominant place in animal husbandry work for which their training under Indian conditions and daily experience should form the best background."

The low standards of education and training which are now commonly accepted for Indian veterinary graduates will never provide the highly trained veterinary services which are essential for the proper study and control of disease and for systematic improvement of livestock in this sub-continent and if the veterinary profession aspires to take its proper place and to justify higher scales of pay it will have to insist on raising its standards, at least as regards selected students, to the levels which have now been adopted in all progressive countries. Low standard of education and training can only mean low status and low scales of pay.

Physiology

Physiology of the Individual in the Tropics

—R. N. Chopra

Nearly 3000 years ago, the Hindu physician Charaka drew attention to the effects of 'airs, waters, places' on different individuals and similar doctrines were propounded by the Greek physician Hippocrates. After the discovery of bacteria as cause of disease emphasis was laid more on the invading parasite than on the invaded individual. It is, however, necessary to divert our attention from the micro-organism to the patient. The climatic factors such as high temperature, humidity, sunlight, etc. exert their effects on man in a subtle and sometimes unmeasurable manner. Residence in the tropical climates for generations has probably endowed the tropical races with certain powers of adaptation which are particularly suitable for his continued existence under the particular condition. Man is fashioning his own evolution by struggling to adapt himself to his climatic environment and therefore he is bound to receive modifying impressions from them. The physiological functions of a tropical individual may not be indentical with those of staying in the temperate climates. The tropical man is said to differ so far as his resistance to disease, energy levels, sexual maturity, skin sensations, nervous and mental impression, physical features, blood and respiratory functions are concerned from the residents of temperate climes but no reliable data are available. The normal physiological reactions of the tropical races should be studied with special reference to the "airs, waters and places." Not that one should study micro-organisms less but that more attention should be paid to the environment.

The question of Indian dietaries is of utmost importance and conflicting views have been expressed by authorities. In this connection Col. Chopra's views are interesting. "It has been pointed out" the speaker said "that in many parts of the world those who consume a diet with high protein content have a better physique and are more virile than others of the race who for one reason or another consume less protein. In the north of Italy, for instance, where the protein consumption is higher, the physique is better than in the south. The same statement has been made about India, although here racial differences may have something to do with the differences."

"On the other hand, the fact cannot be overlooked that the meatless diet of some of the finest soldiers of the Indian army has a low protein content. There is already a considerable volume of opinion that the protein intake in the tropics should be less than in temperate climates and the Chittenden and Voit standards of protein quots may not be applicable to the Indian dietary."

"It is well known that protein food by virtue of its specific dynamic action, generates a good deal of heat. The Eskimos who live in the arctic zone, consume large quantities of meat sufficient to raise their metabolism over 30 per cent. which is an obvious practical advantage. Such a diet in the tropics would be considered unsatisfactory as it would throw an additional burden on the heat regulating mechanism which is already overtaxed. From this point of view a low protein vegetarian diet seems logical and advisable in the tropics. Recent researches have shown that the main deficiency in the Indian dietary is the lack of protein of high biological value and certain salt and this defect can be easily overcome by taking small quantities of milk.

From the point of view of adaptation to a tropical environment a diet comparatively poor in fat has obvious advantages. In the colder parts of the world, where harder physical work can be, and often is performed, a fairly high caloric intake is necessary and this cannot be supplied without including a generous proportion of fat. A caloric intake of a Canadian lumberman of 9000 for example could not be consumed as starch without cutting too much strain on the demands of the alimentary canal. Fat is much less bulky than cereal foods and, bulk for bulk, is a much richer source of energy and heat. Besides, in the tropics an unduly large layer of body fat external or internal is not so necessary as in the cooler regions which naturally leads to a diminished demand for it in the dietary."

The prevailing diet of the masses in the tropics consists predominantly of carbohydrates. This is

physiologically of great advantage and should not be criticised too lightly, as is often the vogue. On a carbohydrate diet, an increased amount of water is available for evaporation and urine secretion in case of necessity. Carbohydrates are always first to be metabolised and during this process, they can absorb and retain a considerable amount of fluid in the system which is naturally of immense help in the tropics.

Col. Chopra in his concluding remarks observed:

" The idea that living bodies receive modifying impression both as regards form and quality, from the physical environment is of ancient origin and may be said to be definitely established by the experimental physiological data now available.

The human organism (the microcosmos) swings in a definite rhythm with the macrocosmos (atmospheric environment). In the interplay of the meteorological rhythm with the biological rhythm of the individual, there may be synchronization, amplification, summation or negation of effects, depending on the type and reactivity of the individual. It is conceivable, for example that a long thin, flaccid individual will react to an environmental feature such as atmospheric temperature, differently from a florid stocky and strong type of individual. This brings us to the important question of constitution and shows how the question of normality may be inter-related ultimately to the constitutional types.

The immediate effects of tropical heat and humidity on the inhabitants of cooler climates are known. Most of the physiological measurements have been recorded either on white races migrating to the tropics or at best on white settlers in the tropics. But these data cannot be used satisfactorily to explain how a native of the tropical climate would react to such varieties. These records of altered physiological manifestations are no doubt useful indications of the type of variations to be expected, but any comparison with the European figures as the standard will naturally be of doubtful value."

The question of basal metabolism and the inter-related problem of optimum diet in the tropics needs further investigation even though the available data are by no means meagre. There seems to be some evidence to show that metabolism in the tropics is slightly lower than in cooler climates. As this observation fits in remarkably well with the known physiological facts regarding heat regulation in the tropics and the diet in the tropics is predominantly rich in carbohydrates and poor in fats and proteins European investigators are prone to lean to this view. Work in the Calcutta School of Tropical Medicine, however, has shown that there is hardly any difference in the basal metabolic rate in apparently healthy Indians (Bengalees) subsisting on an ordinary mixed diet."

The general belief is that sexual maturity is gained earlier in the tropics than in cooler climates. Recent researches however tend to indicate that the reverse is probably true. Much useful work could be done in this connection in India. It is probable that the final answer to these and to many such conflicting hypotheses will be found through a study of the endocrine inter-relationships.

In modern medicine and physiology, a consideration of the environmental influence has been relegated to the background for it has been thought that all acute infectious processes and normal physiological events run a comparatively steady course, uninfluenced by environmental factors. Enough scientific evidence is now available, which leaves little room for doubt that environmental factors are important forces to be reckoned with and that if these are studied in greater detail, particularly with reference to the changes that they might produce in the human organism, a new branch of physiology may be developed in this country. The material is in abundance; but it needs the sickle of properly organised and directed research to garner a harvest which will be of the greatest value to us in India as well as to the world at large.

Psychology

Ambivalence

—Dr G. S. Bose

Opposite groups of tendencies exist side by side in the human mind. Generally these tendencies find alternate satisfaction in different types of action. Sometimes however they clash with one another giving rise to anomalous behaviour. When in any act there is evidence of the simultaneous presence of defience and obedience, or of love and hate, or of pleasantness and unpleasantness or of opposite judgements the behaviour is called ambivalent. Strictly speaking the term ambivalence should be reserved for those cases only in which the peculiarty in the conduct is due to the conflict of two opposing traits one of which remains unconscious. When we say that a son's attitude towards his father is ambivalent we do not mean that he sometimes hates him and sometimes loves him, but that his behaviour is to be interpreted as a conscious love reaction mixed up with an unconscious hate-reaction or vice versa. In such cases the conscious emotion attached to the act is either of love or one of hate. Instances of ambivalence are to be found in normal children and less frequently in normal adults as well. It is however in certain types of insanity known as dementia paraecox that ambivalence attains a pathological development. These patients often do the exact of what is demanded of them. In some instances it is possible to control them and make them follow a required course of action by asking them to do the opposite. A patient of this type when asked to receive something stretches out his hand but at the same time keeps his palm down. There may be no other evidence of hositility or defience.

Psychoanalysts have shown that in early childhood our libido which provides the energy for sexual love, is directed towards the parent of the opposite sex with the result that the parent of the same sex is considered a rival in love and becomes an object of hate in the unconscious mind of the child. In the conscious mind however love for both the parents may be the dominant emotion. Love and hate thus get mixed up and provide the basis for the arousal of ambivalence. Then again in the earlier stage of libido development oral activities form the chief manifestations of love. The child tries to eat everything that it loves. The act of eating destroys the loved object. The oral libido thus loves and destroys at the same time and Freud says that this form of love is hardly to be distinguished from hate in its behaviour towards the object: the cannibal has a devouring love for his enemy. This oral love is also considered to be a responsible factor in the genesis of ambivalence.

Psychoanalysts have sought to explain ambivalence on the basis of the antithesis between love and hate. In positing such an opposition we fail to note what we call love or hate are complex situations made up of wishes, feelings and emotions. Love-wish is not the same thing as love emotion. The opposition between love and hate when there is any is to be sought for in the domain of love-wish and hate-wish and not in the love-emotion and hate-emotion, nor in pleasure and pain. The act of killing or destroying is often associated with the emotion of hate and it is quite easy to confuse the wish to destroy with the emotion of hate. Emotions and feelings are more or less like colourings. The act of destruction itself may be pleasurably toned. One might with perfect justification say in certain situations, " I would love to kill my enemy." Revenge may certainly be sweet.

Love and hate and pleasure and pain are opposites only when they evoke opposite types of activities otherwise they may be considered as so many different experiences. The same act may be pleasurable to day and painful to-morrow. The arousal of pleasure or pain or of love or hate depends on many factors. Feelings and emotions of any specific type are not inherent in specific acts. Neither can pleasurable and painful wishes nor love and hate wishes be listed under two separate classes. The same wish may be invested with either love or hate, pleasure or pain so the antithesis between pleasure and pain and love and hate do not really exist. When an opposition is present at all it is traceable to contradictory action attitude and is independent of the feelings and emotions. The real opposition is to be noted only in the domain of wish and the genesis of ambivalence is to be looked for in this direction.

From the standpoint of action attitude wishes may be broadly classed under two heads *viz.*, active and passive. If we examine the nature of active and passive wishes with reference to their object choice we find that some of them correspond to one another in a very striking way, *e.g.*, the active wish to kiss a loved person has its exact counterpart in the passive wish to be kissed by that person. The action attitudes of two such wishes being exact opposite they cannot obviously arise in consciousness simultaneously but the corresponding verbal expressions may both be conscious at the same time. There is a regular sequence of arousals of these opposite wishes. The satisfaction of one invariably gives rise to the conscious demand for the other. In kissing we expect to be kissed in return and in being kissed we return kiss. Unless both the active and the passive acts are gone through a feeling of incompleteness and tension persists. This traceable to the operations of the unsatisfied wish. The corresponding active and passive wishes are thus seen to be more or less inseparable and to form pairs. Satisfaction, whether voluntary or involutary, of one of the elements of the pair serves as a stimulus to the arousal of the other in consciousness. Pairs of active and passive wishes are generally to be found in our dealings with other sentient individuals of our own species *i.e.*, in love and social intercourse. Since these pairs of active and passive wishes are to be found in all persons a kiss evokes a counter-kiss, a blow evokes a counter-blow, a visit evokes a return visit and so on. This is the mechanism of all reciprocal and retaliatory actions. The law that governs such actions is the Mosaic Law.

The presence of paired wishes both in the subject and in the reciprocating sentient object leads to the formation of a special bond between them. The subject can easily appreciate the position of the object in acts of this type. During kissing, for instance, the subject's desire to be kissed remains latent and it is latent desire that enables him to realise the position of the object who is invested with the same desire. The subject's latent counter-wish is supposed to be the conscious wish of the reciprocating object. This serves as bond of identification between the subject and the object. Once the bond is established the ego can transfer itself to the object's position and appreciate the latter's reciprocal tendency. Under certain conditions the bond of identity remains incomplete and the mobility of the ego to go over to the object's position is impaired. Struggle and strain are the inevitable during fulfilment of the conscious component wish of the pair. It is under such circumstances that hate, disgust, pain, fear and other unpleasant experiences arises and ambivalence develops. A short of compromise often takes place between the conscious and the unconscious elements of the pair of opposite wishes. For example the conscious desire to receive any thing is in the first instance opposed by the unconscious desire to make a gift of the thing and then a compromise is effected so that although the person concerned extends his hand to receive the thing he unconsciously keeps his palm down. A typical ambivalent situation is thus created.

The impairment of the mobility of the ego to go over to the position of the object is the central factor in ambivalance. Childhood influences are responsible for bringing this about. If there is a one-sided influence in the childhood favouring the satisfaction of only one of the elements of the pair of opposite wishes, repression results and the mobility of the ego suffers in consequence. For instance if a child is constantly allowed to have its own way in everything and is never made to feel any restraint, its active sadistic wishes (libidinous tendencies to inflict cruelty on others) will have more oportunities for actual satisfaction than its masochistic ones (libidinous desire to suffer cruelty). The "Channala" for sadistic discharge will develop at the expense of the masochistic outlet so that after a time, the accumulated tension of latent masochism becomes a disturbing factor and its channels of discharge being ill-developed, its mobility suffers. In sadistic act the part of the ego that goes over to the situation of the object plays the masochistic role. If this masochistic half is ill-developed it cannot be transferred to the object situation and the sadistic act itself loses its pleasurable tone. It shows signs of machochistic compromise or in other words ambivalence develops. It is represented masochism that makes sadism ambivalent and vice versa. So with all other pairs of opposite wishes; active homo-sexuality represses passive homosexuality and vice versa; the desire to play the mother's role represses the child's œdipus cravings and 'vice versa' and so on. Ambivalence appears whenever there is repression of this type. It is therefore not a fundamental trait of mental life. It is the outcome of the conflict between opposite wishes that go to form pairs.